ANNEXES CHAPTER 3: THE CGE MODEL

Annex 3.1. UK sales shares and purchase shares at end of 2017-2019 period

	UK sales shares (%) by value in 2019			UK purchase shares (%) by value in 2019		
	Domestic	**EU**	**RoW**	**Domestic**	**EU**	**RoW**
Paddy rice	26.4	70.3	3.3	0.7	8.5	90.8
Wheat	93.9	5.5	0.6	87.2	6.1	6.6
Other cereals	83.6	13.9	2.5	76.7	17.1	6.2
Horticulture	81.8	12.8	5.5	26.6	35.0	38.3
Oilseeds	94.0	5.9	0.1	62.1	3.8	34.1
Other crops	87.5	9.4	3.1	408	30.1	29.1
Plant fibres	12.5	28.0	59.6	5.1	15.4	79.5
Cattle, sheep	95.6	2.9	1.5	94.7	4.0	1.3
Pigs, poultry	88.1	5.7	6.3	88.3	7.9	3.8
Wool	15.9	32.5	51.6	8.6	26.2	65.2
Red meat	88.5	10.5	1.0	71.1	14.2	14.7
White meat	87.8	9.8	2.4	59.6	33.6	6.8
Vegetable oils	83.2	8.9	7.9	27.0	33.6	39.5
Dairy	76.5	20.1	3.4	73.8	25.3	1.0
Processed rice	86.9	12.1	1.0	30.9	30.7	38.4
Processed sugar	68.8	30.6	0.6	39.1	21.1	39.8
Other food	81.3	9.4	9.3	72.9	20.0	7.1
CROPS	88.0	9.3	2.7	45.4	25.0	29.6
LIVESTOCK	94.6	2.9	2.5	94.0	4.0	2.0
MEAT	88.1	10.1	1.8	63.8	26.6	9.6
AGRICULTURE	92.0	5.4	2.6	67.1	15.6	17.3
FOOD	81.9	10.7	7.5	70.5	21.8	7.7

Notes: Raw sugar and raw milk are non-tradable sectors.

Annex 3.2. Ad-valorem average applied tariff rates in 2019 (pre-Brexit)

	UK tariffs on imports from non-EU region(%)	Non-EU tariffs imposed on imports from UK (%)
Paddy rice	3.2	8.8
Wheat	18.3	22.1
Other cereals	1.4	8.4
Horticulture	3.0	8.5
Oilseeds	0.0	5.3
Raw sugar	n/t	n/t
Other crops	0.8	10.3
Plant fibres	0.0	0.7
Cattle, sheep	2.5	3.3
Pigs, poultry	8.2	6.1
Raw milk	n/t	n/t
Wool	0.0	25.9
Red meat	44.5	26.8
White meat	20.5	10.9
Vegetable oils	1.9	54.8
Dairy	24.5	17.7
Processed rice	17.3	7.6
Processed sugar	17.8	5.7
Other food	7.1	14.2

Notes: n/t non-tradable

Annex 3.3. Part-worths of trade and CAP shocks on UK production (%) under FTA (Scenarios 1 and 2)

	Scenario 1: FTA+			Scenario 2: FTA-	
	EU imposed trade costs	UK imposed trade costs	vs baseline	Eliminate first pillar CAP	vs baseline
Paddy rice	-2.1	-1.1	-3.5	-14.1	-20.7
Wheat	0.3	0.1	0.4	-5.4	-4.9
Other cereals	0.2	0.1	0.3	-3.6	-3.3
Horticulture	0.8	-0.2	0.4	-5.8	-5.3
Oilseeds	0.2	-0.3	-0.1	-3.3	-3.3
Raw sugar	-0.6	0.1	-0.5	-2.4	-3.1
Other crops	0.1	-0.1	-0.1	-1.6	-1.8
Plant fibres	1.1	-0.8	0.1	-15.7	-15.7
Cattle, sheep	-0.6	1.2	0.6	-2.7	-2.1
Pigs, poultry	-0.3	1.4	1.1	-2.8	-1.7
Raw milk	-1.3	0.8	-0.3	-2.9	-3.2
Wool	-0.8	-1.2	-2.0	-16.0	-18.6
Red meat	-1.3	0.8	-0.2	-2.8	-3.0
White meat	-0.9	4.0	3.5	-2.8	0.7
Vegetable oils	-0.1	-0.3	-0.4	-0.4	-0.7
Dairy	-2.8	1.8	-0.6	-3.0	-3.7
Processed rice	0.0	0.7	0.6	-0.2	0.4
Processed sugar	-1.0	0.1	-0.9	-3.3	-4.3
Other food	0.1	0.0	0.1	-0.4	-0.2
CROPS	0.3	-0.1	0.2	-4.1	-3.8
LIVESTOCK	-0.8	1.1	0.5	-2.8	-2.3
MEAT	-1.0	2.7	2.0	-2.8	-0.8
AGRICULTURE	-0.4	0.7	0.4	-3.3	-2.9
FOOD	-0.3	0.6	0.4	-1.0	-0.6

Annex 3.4. Part-worths of trade and CAP shocks on UK production (%) under UTL (Scenarios 3 and 4)

	Scenario 3: UTL+					Scenario 4: UTL -	
	Trade costs		UK-ROW tariff eliminations				
	EU imposed	UK imposed	ROW tariffs	UK tariffs	vs baseline	Eliminate first pillar CAP	vs baseline
Paddy rice	-8.2	-1.8	-4.5	1.0	-14.3	-16.0	-34.8
Wheat	0.1	0.1	-0.4	-1.6	-1.8	-5.6	-7.7
Other cereals	0.0	0.2	-0.8	0.6	0.0	-3.6	-3.5
Horticulture	1.0	0.0	-1.3	1.4	0.9	-5.8	-4.7
Oilseeds	-0.1	-0.4	5.5	1.5	7.6	-3.2	4.6
Raw sugar	-2.7	0.3	-1.5	-2.8	-6.6	-2.4	-9.2
Other crops	-0.7	0.3	0.7	1.6	1.8	-1.6	0.2
Plant fibres	1.3	-1.5	-3.6	3.5	-0.5	-15.9	-16.5
Cattle, sheep	-1.7	1.6	1.4	-7.9	-6.6	-2.8	-9.6
Pigs, poultry	-0.8	2.1	0.1	-1.2	0.5	-2.9	-2.4
Raw milk	-2.5	1.6	1.4	0.8	1.6	-2.8	-1.2
Wool	1.2	-2.4	46.4	5.3	49.8	-11.5	43.7
Red meat	-2.7	0.1	1.3	-24.2	-27.1	-3.0	-30.3
White meat	-2.1	6.2	-0.3	-5.9	-1.6	-2.9	-4.7
Vegetable oils	-0.9	-2.5	103.9	-0.6	94.7	-0.5	94.2
Dairy	-5.6	3.7	3.1	0.9	3.1	-3.0	0.0
Processed rice	-1.4	1.5	-1.0	-10.8	-12.2	-0.2	-12.3
Processed sugar	-4.3	0.3	-2.4	-4.9	-11.5	-3.3	-14.8
Other food	-0.4	0.2	4.4	0.5	4.7	-0.4	4.3
CROPS	0.1	0.1	0.3	0.5	1.0	-4.1	-3.1
LIVESTOCK	-1.7	1.7	1.1	-3.2	-2.0	-2.8	-4.9
MEAT	-2.4	3.7	0.3	-13.2	-11.8	-2.9	-15.0
AGRICULTURE	-1.1	1.1	0.8	-1.8	-0.9	-3.3	-4.2
FOOD	-1.2	1.1	3.7	-1.9	2.0	-1.0	0.9

Annex 3.5. Part-worths of trade and CAP shocks on UK production (%) under WTO

	Scenario 5: WTO+							Scenario 6: WTO-	
	Trade costs		UK-EU tariff increases		UK-RoW tariff increases				
	EU imposed	UK imposed	EU tariffs	UK tariffs	RoW tariffs	UK tariffs	vs baseline	Eliminate first pillar CAP	vs baseline
Paddy rice	-6.3	-1.5	-6.2	-4.0	0.7	-0.4	-19.1	-16.6	-40.1
Wheat	0.1	0.3	-0.6	0.2	0.1	0.1	0.4	-5.1	-4.4
Other cereals	0.0	0.2	0.3	-0.3	0.1	-0.2	-0.2	-3.6	-3.8
Horticulture	0.5	-0.1	1.5	-1.3	0.2	-0.5	-0.3	-5.9	-6.2
Oilseeds	-0.3	-0.3	1.2	-1.4	0.1	-0.4	-1.3	-3.3	-4.6
Raw sugar	-1.0	0.4	-12.1	1.9	0.2	2.0	-8.2	-2.2	-10.2
Other crops	-0.6	0.2	0.5	-1.1	-0.1	-0.4	-1.6	-1.7	-3.4
Plant fibres	0.5	-1.4	3.7	-3.4	0.4	-1.0	-2.0	-16.3	-18.9
Cattle, sheep	-0.6	1.6	-2.9	4.0	-0.1	2.6	5.4	-2.4	3.1
Pigs, poultry	-0.4	2.0	-0.5	3.4	0.0	0.5	5.0	-2.8	2.4
Raw milk	-1.1	1.2	-4.5	3.3	-0.1	-0.2	-0.1	-2.7	-2.6
Wool	-2.6	-1.6	4.0	-4.0	-4.7	-1.2	-10.8	-16.7	-28.6
Red meat	-0.2	0.2	-7.3	6.2	0.0	7.9	9.4	-2.3	7.3
White meat	-0.6	5.6	-3.2	12.5	0.1	2.0	18.3	-2.5	15.9
Vegetable oils	-0.9	-0.5	-1.3	1.7	-2.7	0.2	-3.3	-0.4	-3.6
Dairy	-2.5	3.0	-9.9	7.6	-0.3	-0.1	0.4	-2.5	-1.8
Processed rice	-0.5	1.5	-5.1	5.9	0.2	2.0	4.1	-0.2	3.9
Proc. sugar	-1.5	0.6	-19.9	3.5	0.3	3.3	-13.3	-2.8	-15.9
Other food	-0.3	0.2	-1.4	0.2	-0.6	-0.1	-2.0	-0.4	-2.3
CROPS	0.0	0.1	0.2	-0.7	0.1	-0.2	-0.8	-4.1	-4.7
LIVESTOCK	-0.7	1.6	-2.8	3.6	-0.1	1.1	3.5	-2.6	1.0
MEAT	-0.4	3.5	-4.9	10.0	0.1	4.3	14.8	-2.4	12.5
AGRICULTURE	-0.5	1.0	-1.7	2.0	0.0	0.6	1.9	-3.1	-1.1
FOOD	-0.5	1.0	-2.9	2.5	-0.5	0.7	0.8	-0.9	0.0

Annex 3.6. Part-worths of trade and CAP shocks on UK market prices (%) under FTA

	Scenario 1: FTA+			Scenario 2: FTA-	
	EU imposed	UK imposed	vs baseline	Eliminate first pillar CAP	vs baseline
Paddy rice	-1.2	0.1	-1.1	2.0	1.3
Wheat	-1.1	0.7	-0.2	3.9	3.6
Other cereals	-1.1	0.9	-0.1	3.0	2.8
Horticulture	-0.2	0.8	0.7	1.3	1.7
Oilseeds	-1.0	0.6	-0.3	4.1	3.8
Raw sugar	-1.1	0.7	-0.4	5.8	6.2
Other crops	-0.6	0.6	0.0	0.9	0.9
Plant fibres	0.0	0.3	0.3	0.2	0.4
Cattle, sheep	-1.2	1.4	0.4	3.8	4.3
Pigs, poultry	-1.0	1.1	0.2	2.5	2.7
Raw milk	-1.8	1.2	-0.4	4.3	3.9
Wool	-0.2	0.9	0.8	0.3	1.0
Red meat	-0.6	1.0	0.5	1.0	1.5
White meat	-0.5	1.9	1.5	0.8	2.2
Vegetable oils	-0.1	0.8	0.6	0.1	0.7
Dairy	-0.7	1.7	1.2	1.1	2.2
Processed rice	-0.2	0.5	0.4	0.1	0.4
Processed sugar	-0.3	0.5	0.2	0.5	0.7
Other food	-0.4	0.6	0.2	0.2	0.4
CROPS	-0.7	0.7	0.0	2.5	2.6
LIVESTOCK	-1.3	1.3	0.1	3.6	3.7
MEAT	-0.5	1.6	1.1	0.9	2.0
AGRICULTURE	-1.1	1.1	0.1	3.2	3.3
FOOD	-0.5	0.9	0.4	0.4	0.8

Annex 3.7. Part-worths of trade and CAP shocks on UK market prices (%) under UTL

	Scenario 3: UTL+					Scenario 4: UTL-	
	Trade costs		UK-RoW tariff eliminations				
	EU imposed	UK imposed	RoW tariffs	UK tariffs	vs baseline	Eliminate first pillar CAP	vs baseline
Paddy rice	-2.4	0.2	1.2	-0.9	-2.0	2.5	1.3
Wheat	-1.9	1.2	2.6	-3.3	-1.4	3.9	2.4
Other cereals	-1.9	1.5	2.2	-2.4	-0.5	2.9	2.2
Horticulture	-0.4	1.9	0.6	-1.7	0.4	1.2	1.4
Oilseeds	-1.7	1.0	4.1	-1.7	2.0	3.9	5.3
Raw sugar	-2.3	1.2	1.4	-3.0	-2.9	6.1	4.2
Other crops	-1.0	1.2	1.5	-1.2	0.4	0.9	1.1
Plant fibres	0.0	0.7	0.0	0.1	0.8	0.2	0.9
Cattle, sheep	-2.1	2.4	2.5	-4.6	-1.9	4.0	2.4
Pigs, poultry	-1.6	1.8	1.8	-2.6	-0.6	2.5	1.8
Raw milk	-3.1	2.2	3.3	-2.5	0.2	4.1	4.1
Wool	-0.1	1.6	1.6	0.0	3.2	0.2	3.2
Red meat	-0.7	1.3	1.1	-11.8	-10.6	0.9	-9.9
White meat	-0.6	3.2	1.1	-3.8	-0.1	0.8	0.5
Vegetable oils	-0.1	1.8	0.9	-0.8	1.9	0.1	1.9
Dairy	-1.0	3.3	1.6	-1.5	2.5	1.0	3.4
Processed rice	-0.2	1.1	0.4	-6.1	-5.0	0.0	-4.9
Processed sugar	-0.4	0.9	0.6	-7.7	-6.7	0.5	-6.2
Other food	-0.5	1.4	1.1	-1.2	0.8	0.2	0.9
CROPS	-1.3	1.4	1.9	-2.1	0.0	2.5	2.3
LIVESTOCK	-2.3	2.2	2.6	-3.4	-0.8	3.6	2.8
MEAT	-0.7	2.4	1.1	-7.0	-4.3	0.8	-3.6
AGRICULTURE	-1.9	1.9	2.3	-2.9	-0.5	3.2	2.6
FOOD	-0.6	1.7	1.1	-2.3	0.0	0.4	0.3

Annex 3.8. Part-worths of trade and CAP shocks on UK market prices (%) under Brexit-WTO

	Trade costs		Scenario 5: WTO+ UK-EU raising tariffs		UK-ROW raising tariffs			Scenario 6: WTO-	
			EU tariffs	UK tariffs	ROW tariffs	UK tariffs		Eliminate first pillar	
	EU imposed	UK imposed					vs baseline	CAP	vs baseline
Paddy rice	-1.9	0.2	-2.2	0.4	-0.2	0.2	-3.3	2.8	0.6
Wheat	-1.3	1.2	-2.7	2.5	-0.3	0.8	0.9	4.2	5.3
Other cereals	-1.2	1.4	-2.4	2.4	-0.3	0.7	1.1	3.1	4.3
Horticulture	-0.3	1.6	-0.5	1.7	-0.1	0.4	3.0	1.3	4.2
Oilseeds	-1.2	0.9	-1.7	1.6	-0.3	0.5	0.2	4.3	4.7
Raw sugar	-1.3	1.1	-6.2	2.5	-0.2	1.3	-2.4	6.6	5.3
Other crops	-0.8	1.0	-0.9	1.0	-0.2	0.3	0.6	1.0	1.6
Plant fibres	0.0	0.6	0.0	0.0	0.0	0.0	0.6	0.2	0.8
Cattle, sheep	-1.2	2.1	-2.9	3.4	-0.3	1.4	3.5	3.9	7.3
Pigs, poultry	-1.1	1.6	-1.9	2.9	-0.3	0.7	2.6	2.6	5.3
Raw milk	-1.8	1.9	-4.6	4.3	-0.4	0.8	1.3	4.6	6.1
Wool	-0.3	1.3	0.0	0.1	-0.3	0.0	0.7	0.3	1.1
Red meat	-0.7	1.1	-1.0	3.9	-0.2	3.1	6.7	1.2	7.9
White meat	-0.5	2.6	-0.8	5.1	-0.2	1.1	7.7	0.9	8.6
Vegetable oils	-0.1	1.5	-0.1	0.9	-0.1	0.2	2.3	0.1	2.3
Dairy	-0.8	2.4	-1.4	6.1	-0.3	0.4	7.2	1.3	8.5
Processed rice	-0.2	0.9	-0.1	2.8	-0.1	1.1	4.5	0.1	4.5
Proc. sugar	-0.3	0.7	-0.7	4.4	-0.1	3.5	7.6	0.7	8.3
Other food	-0.5	1.1	-0.4	1.9	-0.2	0.3	2.4	0.2	2.6
CROPS	-0.9	1.2	-1.7	1.8	-0.2	0.6	1.2	2.7	4.0
LIVESTOCK	-1.3	1.9	-3.2	3.5	-0.4	1.0	2.5	3.8	6.4
MEAT	-0.6	2.0	-0.9	4.6	-0.2	1.9	7.3	1.0	8.3
AGRICULTURE	-1.2	1.7	-2.6	2.9	-0.3	0.8	2.0	3.4	5.5
FOOD	-0.5	1.4	-0.6	2.7	-0.2	0.6	3.7	0.4	4.1

Annex 3.9. Impacts on UK agricultural factor markets vs baseline.

	Employment	Wages	Land supply	Rent	Yield
FTA					
Scenario1: FTA+	0.3	-0.6	0.0	1.2	0.2
Scenario 2: FTA-	-2.3	-4.6	-0.5	-14.9	-2.9
UTL					
Scenario 3: UTL+	-0.7	0.1	-0.5	-2.8	-1.7
Scenario 4: UTL-	-3.6	-4.0	-0.9	-18.8	-4.9
WTO					
Scenario 5: WTO+	1.7	0.1	0.1	4.9	1.8
Scenario 6: WTO-	-0.6	-3.6	-0.6	-10.6	-0.9

Annex 3.10. UK agri-food trade balances volumes (millions of pounds, 2011 prices)

	UK trade balance with EU regions				UK trade balance with non-EU regions				UK trade balance with the World			
	Base 2026	**S1: FTA+**	**S3: UTL+**	**S5: WTO+**	**Base 2026**	**S1: FTA+**	**S3: UTL+**	**S5: WTO+**	**Base 2026**	**S1: FTA+**	**S3: UTL+**	**S5: WTO+**
Paddy rice	-16	3	9	7	-171	-3	-7	-7	-187	0	1	0
Wheat	67	-12	25	-74	-98	-6	-53	-31	-31	-18	-29	-105
Oth. cereals	-78	-2	-5	-11	-53	-2	-2	-7	-131	-4	-7	-19
Horticul.	-2239	38	193	206	-2763	-84	-370	-315	-5002	-47	-176	-109
Oilseeds	112	-7	-36	-19	-508	-2	-133	2	-396	-9	-169	-17
Other crops	-1099	40	99	106	-1215	-76	-213	-174	-2314	-36	-114	-68
Plant fibres	-2	0	0	1	-25	0	-1	-1	-27	0	-1	0
Cattle, sheep	-11	-15	19	-69	26	-6	24	-33	16	-20	43	-102
Pigs, poultry	-39	-21	-11	-87	115	-11	9	-53	76	-32	-2	-141
Wool	-4	1	-2	4	-25	-2	23	-9	-30	-1	20	-4
Red meat	-423	50	600	380	-699	-78	-1851	-20	-1122	-27	-1251	360
White meat	-4039	468	2217	2299	-788	-239	-3278	-570	-4827	229	-1061	1729
Veg. oils	-156	8	20	34	-203	-11	118	-38	-360	-3	138	-4
Dairy	-2075	105	371	949	72	-18	-180	-105	-2003	87	191	844
Proc. rice	-82	2	42	30	-107	-4	-55	-27	-188	-1	-13	4
Proc. sugar	-24	1	87	-14	-305	-7	-151	-76	-329	-7	-63	-89
Other food	-8194	58	284	371	530	-74	1308	-1068	-7664	-16	1592	-698
CROPS	-3257	60	286	217	-4834	-173	-781	-536	-8091	-113	-495	-319
LIVESTOCK	-53	-34	5	-152	105	-20	54	-97	51	-55	59	-249
MEAT	-4462	518	2818	2679	-1487	-316	-5130	-590	-5949	202	-2312	2089
AGRIC.	-3310	26	291	65	-4730	-193	-726	-632	-8040	-167	-435	-567
FOOD	-14993	693	3622	4050	-1499	-430	-4090	-1905	-16493	262	-468	2145
TOTAL	-62030	5101	-761	12780	-76117	-390	-4059	-5364	-138147	4711	-4819	7416

Annex 3.11. UK agri-food trade balances volumes with first pillar CAP removal (millions of pounds, 2011 prices)

	UK trade balance with EU regions				UK trade balance with non EU regions				UK trade balance with the world			
	Base 2026	S2: FTA-	S4: UTL-	S6: WTO-	Base 2026	S2: FTA-	S4: UTL-	S6: WTO-	Base 2026	S2: FTA-	S4: UTL-	S6: WTO-
Paddy rice	-16	2	8	7	-171	-2	-6	-7	-187	1	2	1
Wheat	67	-66	-16	-94	-98	-23	-107	-51	-31	-89	-123	-145
Oth. cereals	-78	-10	-13	-19	-53	-4	-4	-9	-131	-14	-17	-29
Horticul.	-2239	-30	133	143	-2763	-147	-438	-385	-5002	-177	-304	-242
Oilseeds	112	-36	-56	-48	-508	-11	-139	-7	-396	-47	-195	-55
Other crops	-1099	32	94	95	-1215	-81	-218	-180	-2314	-49	-125	-84
Plant fibres	-2	-1	-1	0	-25	-2	-3	-4	-27	-3	-4	-4
Cattle, sheep	-11	-48	-14	-98	26	-24	0	-50	16	-72	-14	-148
Pigs, poultry	-39	-34	-22	-101	115	-25	-7	-68	76	-60	-29	-169
Wool	-4	-1	-2	2	-25	-7	20	-14	-30	-7	18	-12
Red meat	-423	-9	567	378	-699	-106	-1944	-48	-1122	-115	-1376	329
White meat	-4039	350	2151	2241	-788	-277	-3399	-621	-4827	73	-1248	1621
Veg. oils	-156	9	20	34	-203	-11	117	-38	-360	-2	138	-4
Dairy	-2075	-6	295	896	72	-36	-234	-124	-2003	-42	60	772
Proc. rice	-82	2	42	30	-107	-4	-55	-27	-188	-1	-13	4
Proc. sugar	-24	-11	76	-16	-305	-14	-161	-86	-329	-24	-84	-102
Other food	-8194	19	247	330	530	-112	1256	-1109	-7664	-93	1503	-779
CROPS	-3257	-111	150	83	-4834	-267	-917	-643	-8091	-378	-767	-560
LIVESTOCK	-53	-83	-39	-198	105	-58	12	-134	51	-141	-27	-332
MEAT	-4462	341	2719	2620	-1487	-384	-5343	-670	-5949	-43	-2624	1950
AGRIC.	-3310	-194	111	-114	-4730	-326	-905	-777	-8040	-520	-794	-892
FOOD	-14993	354	3398	3894	-1499	-559	-4419	-2052	-16493	-205	-1021	1841
TOTAL	-62030	4975	-742	12771	-76117	-89	-3912	-5203	-138147	4886	-4654	7568

Annex 3.12. UK production (%), price (%) and wage (%) impacts from 10% and 30% reductions in the level of UK agricultural unskilled labour in the 2019-2026 period

	FTA: Simulation 1			FTA: Simulation 2			UTL: Simulation 3			UTL: Simulation 4			WTO: Simulation 5			WTO: Simulation 6		
		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%
	vs BASE	vs S1	vs S1	vs BASE	vs S2	vs S2	vs BASE	vs S3	vs S3	vs BASE	vs S4	vs S4	vs BASE	vs S5	vs S5	vs BASE	vs S6	vs S6
Production:																		
CROPS	0.2	-3.3	-12.1	-3.8	-3.3	-11.9	1.0	-3.4	-12.5	-3.1	-3.4	-12.3	-0.8	-3.3	-11.9	-4.7	-3.2	-11.7
LVSK	0.5	-2.6	-9.4	-2.3	-2.4	-9.0	-2.0	-2.6	-9.5	-4.9	-2.5	-8.9	3.5	-2.4	-8.7	1.0	-2.2	-8.2
MEAT	2.0	-2.6	-9.4	-0.8	-2.5	-9.1	-11.8	-2.6	-9.4	-15.0	-2.5	-9.0	14.8	-2.2	-8.3	12.5	-2.2	-8.1
DAIRY	-0.6	-3.2	-11.7	-3.7	-3.1	-11.1	3.1	-3.4	-12.1	0.0	-3.2	-11.7	0.4	-2.3	-8.3	-1.8	-2.2	-8.1
AGRI	0.4	-2.8	-10.4	-2.9	-2.8	-10.1	-0.9	-2.9	-10.6	-4.2	-2.8	-10.2	1.9	-2.7	-9.9	-1.1	-2.6	-9.5
FOOD	0.4	-0.9	-3.4	-0.6	-0.8	-3.2	2.0	-0.9	-3.4	0.9	-0.8	-3.3	0.8	-0.8	-3.0	0.0	-0.8	-2.9
Market prices:																		
CROPS	0.0	2.0	8.1	2.6	2.1	8.6	0.0	1.9	7.7	2.3	2.1	8.3	1.2	2.2	8.9	4.0	2.4	9.4
LVSK	0.1	3.4	13.4	3.7	3.4	13.5	-0.8	3.4	13.2	2.8	3.4	13.2	2.5	3.8	14.8	6.4	3.8	14.8
MEAT	1.1	0.7	2.7	2.0	0.7	2.7	-4.3	0.6	2.1	-3.6	0.6	2.1	7.3	1.0	3.7	8.3	0.9	3.6
DAIRY	1.2	1.0	3.9	2.2	1.0	4.0	2.5	1.0	4.0	3.4	1.1	4.0	7.2	1.4	5.3	8.5	1.4	5.4
AGRI	0.1	2.9	11.4	3.3	2.9	11.7	-0.5	2.8	11.1	2.6	2.9	11.4	2.0	3.2	12.6	5.5	3.2	12.8
FOOD	0.4	0.3	1.2	0.8	0.2	1.1	0.0	0.3	1.0	0.3	0.2	1.0	3.7	0.4	1.5	4.1	0.4	1.5
Unskilled agricultural wages																		
AGRI	-0.6	5.1	17.3	-4.6	5.0	17.1	0.1	5.0	17.0	-4.0	4.9	16.8	0.1	5.3	18.5	-3.6	5.3	18.3

Annex 3.13. UK trade balance volumes (millions of pounds, 2011 prices) from 10% and 30% reductions in the level of UK agricultural unskilled labour in the 2019-2026 period

	FTA: Simulation 1			FTA: Simulation 2			UTL: Simulation 3			UTL: Simulation 4			WTO: Simulation 5			WTO: Simulation 6		
		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%
	vs BASE	vs S1	vs S1	vs BASE	vs S2	vs S2	vs BASE	vs S3	vs S3	vs BASE	vs S4	vs S4	vs BASE	vs S5	vs S5	vs BASE	vs S6	vs S6
CROPS	-113	-207	-757	-378	-207	-755	-495	-219	-800	-767	-220	-797	-319	-184	-689	-560	-187	-698
LVSK	-55	-76	-259	-141	-68	-236	59	-74	-256	-27	-68	-233	-249	-77	-265	-332	-70	-243
MEAT	87	-134	-499	-42	-132	-488	191	-146	-543	60	-144	-531	844	-76	-287	772	-77	-284
DAIRY	202	-218	-816	-43	-210	-788	-2312	-252	-941	-2624	-242	-908	2089	-135	-522	1950	-133	-515
AGRI	-167	-282	-1017	-520	-275	-991	-435	-296	-1058	-794	-288	-1031	-567	-261	-954	-892	-257	-940
FOOD	262	-425	-1608	-205	-415	-1568	-468	-477	-1799	-1021	-466	-1752	2145	-291	-1124	1841	-287	-1106
TOTAL	4711	210	860	4886	226	910	-4819	196	803	4654	212	853	7416	192	788	7568	206	829

Annex 3.14. UK production (%) and price (%) impacts from 10% and 20% devaluations in sterling in the 2019-2026 period

	FTA: Simulation 1			FTA: Simulation 2			UTL: Simulation 3			UTL: Simulation 4			WTO: Simulation 5			WTO: Simulation 6		
		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%
	vs BASE	vs S1	vs S1	vs BASE	vs S2	vs S2	vs BASE	vs S3	vs S3	vs BASE	vs S4	vs S4	vs BASE	vs S5	vs S5	vs BASE	vs S6	vs S6
Production:																		
CROPS	0.2	-1.5	-2.4	-3.8	-1.4	-2.3	1.0	-1.5	-2.6	-3.1	-1.4	-2.3	-0.8	-1.5	-2.1	-4.7	-1.4	-2.0
LVSK	0.5	-1.0	-1.2	-2.3	-0.9	-1.1	-2.0	-1.1	-1.3	-4.9	-1.0	-1.3	3.5	-0.9	-1.3	1.0	-0.9	-1.5
MEAT	2.0	-0.6	-0.9	-0.8	-0.3	-1.1	-11.8	-0.6	-0.9	-15.0	-0.4	-1.3	14.8	-0.3	-1.3	12.5	-0.3	-1.4
DAIRY	-0.6	-0.6	-0.8	-3.7	-0.3	-0.8	3.1	-0.6	-0.8	0.0	-0.4	-0.9	0.4	-0.4	-0.9	-1.8	-0.5	-0.7
AGRI	0.4	-1.2	-1.8	-2.9	-1.1	-1.7	-0.9	-1.3	-1.8	-4.2	-1.0	-1.6	1.9	-1.2	-1.6	-1.1	-1.1	-1.5
FOOD	0.4	-0.4	-0.7	-0.6	-0.3	-0.8	2.0	-0.4	-0.7	0.9	-0.3	-0.9	0.8	-0.3	-1.0	0.0	-0.4	-0.9
Market prices:																		
CROPS	0.0	11.3	24.1	2.6	11.5	24.4	0.0	11.3	24.1	2.3	11.5	24.3	1.2	11.5	24.6	4.0	11.7	24.8
LVSK	0.1	12.1	25.4	3.7	12.2	25.6	-0.8	12.0	25.4	2.8	12.1	25.5	2.5	12.4	26.1	6.4	12.5	26.3
MEAT	1.1	10.7	22.6	2.0	10.8	22.7	-4.3	10.3	21.8	-3.6	10.3	21.9	7.3	11.4	23.7	8.3	11.4	23.8
DAIRY	1.2	10.7	22.3	2.2	10.7	22.3	2.5	10.8	22.6	3.4	10.8	22.7	7.2	11.3	23.4	8.5	11.3	23.4
AGRI	0.1	11.8	24.9	3.3	11.9	25.1	-0.5	11.8	24.9	2.6	11.9	25.1	2.0	12.1	25.5	5.5	12.2	25.7
FOOD	0.4	10.3	21.6	0.8	10.3	21.6	0.0	10.4	21.6	0.3	10.4	21.7	3.7	10.6	22.1	4.1	10.7	22.2

Annex 3.15. UK trade balance volumes (millions of pounds, 2011 prices) 10% and 20% devaluations in sterling in the 2019-2026 period

		FTA: Simulation 1			FTA: Simulation 2			UTL: Simulation 3			UTL: Simulation 4			WTO: Simulation 5			WTO: Simulation 6	
		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%		10%	30%
	vs BASE	vs S1	vs S1	vs BASE	vs S2	vs S2	vs BASE	vs S3	vs S3	vs BASE	vs S4	vs S4	vs BASE	vs S5	vs S5	vs BASE	vs S6	vs S6
CROPS	-113	95	180	-378	78	140	-495	100	187	-767	86	148	-319	87	158	-560	72	123
LVSK	-55	51	115	-141	42	97	59	53	122	-27	45	103	-249	49	103	-332	40	86
MEAT	87	1	102	-42	11	123	191	2	97	60	7	118	844	3	72	772	8	84
DAIRY	202	7	273	-43	14	318	-2312	17	337	-2624	9	389	2089	22	255	1950	33	281
AGRI	-167	147	295	-520	122	237	-435	155	309	-794	130	250	-567	135	263	-892	112	209
FOOD	262	213	1161	-205	251	1238	-468	194	1202	-1021	236	1290	2145	246	1108	1841	269	1159
TOTAL	4711	8749	34742	4886	8740	34729	-4819	6858	31674	4654	6849	31662	7416	9802	36488	7568	9794	36477

ANNEXES CHAPTER 4: THE FAPRI-UK MODEL

Detailed Tables: Main Analysis, Percentage Difference in 2026 compared to the Baseline

Annex 4.1. Projected Changes in the Beef and Sheep Sectors, UK

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Cattle						
Beef cows	1%	-4%	-37%	-45%	19%	15%
Dairy cows	0%	0%	-2%	-2%	6%	5%
Total Cattle	1%	-1%	-16%	-19%	12%	10%
Beef						
Production	1%	0%	-12%	-13%	11%	10%
Domestic use	0%	-1%	16%	16%	-3%	-4%
Export	-1%	-1%	1%	1%	-100%	-100%
Exports from UK to EU-27	-1%	-1%	-6%	-6%	-100%	-100%
Exports from UK to Non-EU	-1%	-2%	55%	55%	-100%	-100%
Import	-2%	-1%	68%	69%	-68%	-66%
Imports from EU-27 to UK	-2%	-1%	-100%	-100%	-100%	-100%
Imports from Non-EU to UK	-3%	-1%	1469%	1481%	199%	216%
Cattle price	1%	2%	-42%	-42%	17%	17%
Cattle price adjusted by export to EU	1%	2%	-36%	-36%	17%	17%
Output value	1%	1%	-44%	-44%	30%	29%
Sheep						
Ewes	0%	-2%	-5%	-9%	-10%	-14%
Total Sheep	0%	-2%	-5%	-8%	-9%	-13%
Sheepmeat						
Production	0%	-2%	-5%	-8%	-9%	-12%
Domestic use	0%	-1%	11%	11%	7%	6%
Export	-1%	-2%	-8%	-9%	-75%	-83%
Exports from UK to EU-27	-1%	-2%	-4%	-5%	-74%	-82%
Exports from UK to Non-EU	0%	-15%	-78%	-96%	-82%	-100%
Import	0%	1%	41%	46%	-15%	-15%
Imports from EU-27 to UK	-1%	-1%	-100%	-100%	-100%	-100%
Imports from Non-EU to UK	0%	1%	59%	65%	-4%	-4%
Sheepmeat price	0%	4%	-19%	-19%	-23%	-23%
Sheepmeat price adjusted by export to EU	0%	4%	-13%	-13%	-23%	-23%
Output value	0%	2%	-18%	-19%	-31%	-32%

Annex 4.2. Projected Changes in the Pig and Poultry Sectors, UK

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Pig						
Sows	1%	0%	-3%	-3%	22%	21%
Total pigs	1%	1%	-2%	-2%	23%	23%
Pigmeat						
Production	1%	1%	-2%	-2%	22%	22%
Domestic use	0%	0%	3%	3%	-8%	-8%
Export	0%	0%	-11%	-11%	-100%	-100%
Exports from UK to EU-27	0%	0%	-16%	-16%	-100%	-100%
Exports from UK to Non-EU	0%	0%	1%	1%	-100%	-100%
Import	-1%	-1%	4%	4%	-62%	-62%
Imports from EU-27 to UK	-1%	-1%	-16%	-16%	-62%	-62%
Imports from Non-EU to UK	0%	0%	11105%	11091%	0%	0%
Pigmeat reference price	1%	1%	-4%	-4%	25%	25%
Output value	1%	1%	-6%	-6%	52%	52%
Poultry						
Production	0%	0%	-1%	-1%	8%	8%
Domestic use	0%	0%	1%	1%	-2%	-2%
Export	-1%	-2%	0%	0%	0%	0%
Exports from UK to EU-27	-2%	-2%	-3%	-3%	-100%	-100%
Exports from UK to Non-EU	0%	0%	8%	8%	235%	235%
Import	-1%	-1%	3%	4%	-24%	-23%
Imports from EU-27 to UK	-1%	-1%	-49%	-49%	-24%	-24%
Imports from Non-EU to UK	0%	0%	1411%	1409%	0%	0%
Chicken price	0%	0%	-3%	-3%	15%	15%
Output value	0%	0%	-4%	-4%	24%	24%

Annex 4.3. Projected Changes in the Livestock Sectors, England

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Cattle						
Beef cows	1%	-2%	-38%	-43%	20%	17%
Dairy cows	0%	0%	-1%	-2%	5%	5%
Total Cattle	1%	-1%	-14%	-16%	11%	10%
Production	1%	0%	-10%	-10%	9%	9%
Sheep						
Ewes	0%	-1%	-5%	-7%	-9%	-11%
Total Sheep	0%	-1%	-5%	-7%	-8%	-11%
Production	0%	-2%	-5%	-7%	-9%	-11%
Pig						
Sows	1%	1%	-3%	-3%	23%	23%
Total pigs	1%	1%	-2%	-2%	24%	24%
Production	1%	1%	-2%	-2%	23%	23%
Poultry						
Poultry production (EW)	0%	0%	-1%	-1%	8%	8%

Annex 4.4. Projected Changes in the Livestock Sectors, Wales

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Cattle						
Beef cows	1%	-4%	-50%	-63%	23%	19%
Dairy cows	0%	0%	-2%	-3%	8%	8%
Total Cattle	1%	-1%	-20%	-24%	15%	13%
Production	1%	0%	-13%	-13%	12%	12%
Sheep						
Ewes	0%	-1%	-8%	-12%	-15%	-19%
Total Sheep	0%	-1%	-8%	-11%	-15%	-19%
Production	0%	-2%	-7%	-10%	-14%	-16%
Pig						
Sows	0%	0%	-2%	-2%	15%	15%
Total pigs	0%	0%	-2%	-2%	19%	19%
Production	0%	0%	-2%	-2%	21%	21%
Poultry						
Poultry production	0%	0%	-1%	-1%	8%	8%

Annex 4.5. Projected Changes in the Livestock Sectors, Scotland

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Cattle						
Beef cows	1%	-6%	-39%	-51%	19%	13%
Dairy cows	0%	0%	-2%	-3%	8%	7%
Total Cattle	1%	-3%	-25%	-32%	16%	12%
Production	1%	-1%	-20%	-21%	16%	14%
Sheep						
Ewes	0%	-5%	-4%	-10%	-7%	-13%
Total Sheep	0%	-5%	-3%	-9%	-6%	-12%
Production	0%	-4%	-3%	-8%	-6%	-11%
Pig						
Sows	1%	0%	-3%	-3%	22%	22%
Total pigs	1%	1%	-3%	-3%	29%	29%
Production	1%	1%	-2%	-2%	24%	23%
Poultry						
Poultry production	0%	0%	-1%	-1%	10%	10%

Annex 4.6. Projected Changes in the Livestock Sectors, Northern Ireland

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Cattle						
Beef cows	1%	-3%	-25%	-30%	14%	10%
Dairy cows	0%	0%	-1%	-2%	5%	4%
Total Cattle	0%	-1%	-11%	-13%	9%	7%
Production	1%	-1%	-10%	-11%	9%	8%
Sheep						
Ewes	0%	-1%	-4%	-6%	-7%	-10%
Total Sheep	0%	-1%	-4%	-6%	-7%	-9%
Production	0%	-2%	-4%	-5%	-6%	-8%
Pig						
Sows	0%	0%	-2%	-2%	14%	14%
Total pigs	0%	0%	-2%	-2%	17%	17%
Production	0%	0%	-1%	-1%	14%	14%
Poultry						
Poultry production	0%	0%	-1%	-1%	6%	6%

Annex 4.7. Projected Changes in the Dairy Sector, UK

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Dairy						
Cow's milk Production	0%	0%	-2%	-2%	7%	6%
Liquid consumption	0%	0%	1%	1%	-3%	-3%
Manufacturing use	1%	0%	-5%	-6%	16%	16%
Prices						
Producer milk price	1%	1%	-8%	-8%	28%	28%
Output Value	1%	1%	-9%	-10%	37%	36%
Cheese price	1%	1%	-7%	-7%	26%	26%
Butter price	0%	0%	-20%	-20%	26%	27%
WMP price	0%	0%	1%	1%	1%	1%
SMP price	0%	0%	1%	1%	1%	1%
Cheese						
Production	1%	0%	-3%	-4%	17%	16%
Domestic use	0%	0%	1%	1%	-4%	-4%
Export	-2%	-3%	-9%	-9%	-100%	-100%
Exports from UK to EU-27	-3%	-4%	-11%	-11%	-100%	-100%
Exports from UK to Non-EU	0%	0%	1%	1%	-100%	-100%
Import	-2%	-1%	2%	3%	-60%	-59%
Imports from EU-27 to UK	-2%	-1%	-2%	-2%	-61%	-60%
Imports from Non-EU to UK	0%	0%	307%	324%	0%	0%
Butter						
Production	0%	0%	-8%	-9%	15%	15%
Domestic use	0%	0%	8%	8%	-8%	-8%
Export	-5%	-6%	-8%	-8%	-100%	-100%
Exports from UK to EU-27	-3%	-3%	-19%	-19%	-100%	-100%
Exports from UK to Non-EU	-37%	-50%	176%	176%	-100%	-100%
Import	-4%	-3%	23%	23%	-98%	-98%
Imports from EU-27 to UK	-4%	-4%	-100%	-100%	-100%	-100%
Imports from Non-EU to UK	0%	0%	1490%	1502%	-80%	-80%

Annex 4.8. Projected Changes in the Dairy Sector, England

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Milk						
Milk production	0%	0%	-2%	-2%	7%	6%
Dairy cows	0%	0%	-1%	-2%	5%	5%
Milk yield per cow	0%	0%	0%	0%	1%	1%
Milk price	1%	1%	-8%	-8%	28%	28%
Output value	1%	1%	-9%	-10%	36%	36%

Annex 4.9. Projected Changes in the Dairy Sector, Wales

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Milk						
Milk production	0%	0%	-3%	-3%	10%	9%
Dairy cows	0%	0%	-2%	-3%	8%	8%
Milk yield per cow	0%	0%	0%	0%	1%	1%
Milk price	1%	1%	-8%	-8%	27%	27%
Output value	1%	1%	-10%	-11%	39%	39%

Annex 4.10. Projected Changes in the Dairy Sector, Scotland

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Milk						
Milk production	0%	0%	-2%	-3%	9%	8%
Dairy cows	0%	0%	-2%	-3%	8%	7%
Milk yield per cow	0%	0%	0%	0%	1%	1%
Milk price	1%	1%	-8%	-8%	28%	28%
Output value	1%	1%	-10%	-11%	39%	39%

Annex 4.11. Projected Changes in the Dairy Sector, Northern Ireland

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Milk						
Milk production	0%	0%	-1%	-2%	5%	5%
Dairy cows	0%	0%	-1%	-2%	5%	4%
Milk yield per cow	0%	0%	0%	0%	1%	1%
Milk price	1%	1%	-5%	-5%	17%	17%
Output value	1%	0%	-6%	-7%	23%	23%

Annex 4.12. Projected Changes in the Crop Sector, UK

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Wheat						
Production	0%	-1%	0%	-1%	1%	1%
Domestic use	0%	0%	-1%	-2%	4%	3%
Export	-1%	-2%	6%	3%	-100%	-100%
Exports from UK to EU-27	-1%	-2%	-21%	-21%	-100%	-100%
Exports from UK to Non-EU	-1%	-3%	103%	88%	-100%	-100%
Import	0%	0%	-1%	-1%	-79%	-78%
Imports from EU-27 to UK	0%	0%	-1%	-1%	-100%	-99%
Imports from Non-EU to UK	0%	1%	-1%	-1%	-19%	-19%
Barley						
Production	0%	-1%	-1%	-2%	-1%	-1%
Domestic use	0%	0%	-1%	-1%	9%	8%
Export	-1%	-3%	-6%	-8%	-43%	-45%
Exports from UK to EU-27	-1%	-2%	-35%	-35%	-85%	-85%
Exports from UK to Non-EU	-1%	-6%	179%	161%	220%	201%
Import	-1%	1%	-10%	-9%	-100%	-100%
Imports from EU-27 to UK	-1%	1%	-10%	-9%	-100%	-100%
Imports from Non-EU to UK	-1%	1%	-21%	-20%	-99%	-99%
Area						
Wheat	0%	-1%	0%	-1%	1%	1%
Barley	0%	-1%	-1%	-2%	0%	-1%
Prices						
Wheat	0%	1%	-2%	-2%	7%	8%
Barley	0%	1%	-8%	-8%	-5%	-5%
Output value						
Wheat	0%	0%	-2%	-3%	8%	9%
Barley	0%	0%	-10%	-10%	-6%	-6%

Annex 4.13. Projected Changes in the Crop Sector, England

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Area						
Wheat	0%	-1%	0%	-1%	1%	1%
Barley	0%	-1%	-1%	-2%	0%	-1%
Yield						
Wheat	0%	0%	0%	0%	0%	0%
Barley	0%	0%	0%	0%	0%	0%
Production						
Wheat	0%	-1%	0%	-1%	1%	1%
Barley	0%	-1%	-1%	-2%	0%	-1%

Annex 4.14. Projected Changes in the Crop Sector, Wales

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Area						
Wheat	0%	0%	0%	0%	1%	1%
Barley	0%	0%	-1%	-1%	-1%	-1%
Yield						
Wheat	0%	0%	0%	0%	0%	0%
Barley	0%	0%	0%	0%	0%	0%
Production						
Wheat	0%	0%	0%	0%	1%	1%
Barley	0%	0%	-1%	-1%	-1%	-1%

Annex 4.15. Projected Changes in the Crop Sector, Scotland

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Area						
Wheat	0%	0%	0%	0%	2%	1%
Barley	0%	-1%	-1%	-2%	-1%	-2%
Yield						
Wheat	0%	0%	0%	0%	0%	0%
Barley	0%	0%	0%	0%	0%	0%
Production						
Wheat	0%	0%	0%	0%	2%	2%
Barley	0%	-1%	-2%	-2%	-1%	-2%

Annex 4.16. Projected Changes in the Crop Sector, Northern Ireland

	S1	S2	S3	S4	S5	S6
	FTA+DP	FTA-DP	UTL+DP	UTL-DP	WTO+DP	WTO-DP
Area						
Wheat	0%	-1%	-1%	-2%	1%	0%
Barley	0%	-1%	-1%	-3%	-1%	-2%
Yield						
Wheat	0%	0%	0%	0%	0%	0%
Barley	0%	0%	0%	0%	0%	0%
Production						
Wheat	0%	-1%	-1%	-2%	1%	0%
Barley	0%	-1%	-2%	-3%	-1%	-2%

ANNEXES CHAPTER: ScotFarm Linear Programming Model

Annex 5.1. FBS sample details

Table 5.1. FBS sample sizes, by country and farm type

Number of Farms	Specialist cereals	General cropping	Specialist dairy	LFA grazing	Lowland grazing	Mixed
England	**354**	**138**	**248**	**220**	**280**	**186**
Very Large	30	57	92	39	34	34
Large	48	16	85	51	51	47
Medium	69	18	47	53	69	38
Small	207	47	24	77	126	67
Northern Ireland	**8**	**6**	**107**	**103**	**39**	**15**
Very Large	0	0	17	0	0	0
Large	1	1	28	8	2	3
Medium	1	2	23	11	6	4
Small	6	3	39	84	31	8
Scotland	**98**	**56**	**50**	**244**	**18**	**65**
Very Large	2	10	27	45	2	6
Large	18	15	18	57	3	20
Medium	22	14	3	33	4	15
Small	56	17	2	79	9	24
Wales	**10**	**3**	**108**	**329**	**59**	**16**
Very Large	0	1	34	45	4	1
Large	1	2	38	96	10	5
Medium	2	0	28	75	14	1
Small	7	0	8	113	31	9

Annex 5.2. Estimated FBI change, by country, farm type & size, and scenario

Table 5.2.1. Specialist cereals, England

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£3,857	£32,451	-£7,641	-£113,034	-£101,000	-£144,612
large	£874	£13,517	-£6,455	-£59,515	-£58,071	-£79,668
medium	£3,954	£8,914	-£5,990	-£37,551	-£40,785	-£56,760
small	£771	£4,029	-£2,497	-£22,094	-£22,789	-£29,938

Table 5.2.2. Specialist cereals, Northern Ireland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	-£292	£4,962	-£6,848	-£41,007	-£36,084	-£48,849
Medium	-£63	£3,151	-£2,163	-£44,505	-£41,384	-£47,153
Small	-£42	-£178	-£628	-£13,715	-£13,925	-£14,418

NB. no very large farms in sample

Table 5.2.3. Specialist cereals, Scotland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£2,426	-£1,457	-£43,500	-£92,331	-£94,251	-£137,689
large	£2,344	-£2,142	-£20,274	-£56,018	-£55,293	-£77,409
medium	£351	-£4,069	-£15,640	-£38,222	-£41,045	-£54,491
small	£47	-£3,351	-£5,818	-£23,027	-£25,469	-£29,084

Table 5.2.4. Specialist cereals, Wales

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
large	-£40	£2,670	-£4,980	-£30,435	-£31,038	-£39,270
medium	£129	£2,171	-£1,714	-£26,004	-£25,612	-£29,790
small	£26	£2,324	-£1,593	-£12,296	-£10,822	-£14,930

NB. no very large farms in sample

Table 5.2.5. General cropping, England

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	-£699	£12,961	-£19,900	-£96,906	-£100,572	-£135,536
large	-£193	£6,838	-£6,107	-£37,909	-£37,358	-£51,188
medium	-£164	£3,663	-£4,382	-£32,271	-£33,514	-£42,267
small	-£146	£2,103	-£3,907	-£18,185	-£20,252	-£26,788

Table 5.2.6. General cropping, Northern Ireland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	£0	£60,499	-£13,168	-£76	£49,391	-£19,745
Medium	-£9	£13,486	-£3,127	-£6,180	£7,360	-£10,777
Small	-£42	£1,693	-£890	-£12,879	-£11,228	-£14,050

NB. no very large farms in sample

Table 5.2.7. General cropping, Scotland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	-£381	-£6,373	-£22,498	-£65,933	-£70,238	-£86,317
large	-£301	-£3,177	-£16,354	-£47,140	-£48,610	-£61,932
medium	-£174	-£1,826	-£7,130	-£31,125	-£30,321	-£36,191
small	-£171	-£3,449	-£4,650	-£18,544	-£21,324	-£22,535

Table 5.2.8. General cropping, Wales

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	-£103	-£2,308	-£11,638	-£38,835	-£41,528	-£51,159
large	-£19	-£401	-£1,496	-£10,121	-£10,973	-£12,146

NB. no small or medium farms in sample

Table 5.2.9. Specialist Dairy, England

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£2,252	£88,805	£1,431	-£21,939	£61,299	-£18,684
large	£1,522	£28,823	-£4,868	-£16,027	£14,391	-£16,842
medium	£1,090	£17,566	-£3,524	-£11,428	£7,119	-£11,816
small	£717	£11,304	-£1,873	-£7,500	£4,593	-£7,092

Table 5.2.10. Specialist dairy, Northern Ireland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	£4,784	£154,697	-£22,793	-£34,902	£127,523	-£52,785
Large	£2,667	£69,726	-£9,423	-£21,786	£50,592	-£28,882
Medium	£1,418	£34,725	-£4,958	-£17,457	£18,640	-£21,511
Small	£600	£19,266	-£2,663	-£9,709	£10,323	-£11,584

Table 5.2.11. Specialist dairy, Scotland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£11,905	£169,082	-£77,142	-£32,967	£121,673	-£124,351
large	£3,202	£55,804	-£10,065	-£22,064	£29,967	-£35,973
medium	£2,457	£45,516	-£16,303	-£9,295	£33,186	-£28,557
small	£987	£17,440	-£2,672	-£12,213	£4,339	-£15,744

Table 5.2.12. Specialist dairy, Wales

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£6,046	£156,353	-£198,904	-£21,193	£90,814	-£236,516
large	£2,911	£75,597	-£115,659	-£14,158	£28,846	-£136,010
medium	£1,709	£44,349	-£62,221	-£10,223	£21,123	-£77,164
small	£720	£21,990	-£31,137	-£6,824	£7,355	-£40,471

Table 5.2.13. LFA grazing, England

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£571	£5,963	-£47,112	-£50,403	-£62,544	-£110,173
large	£167	-£9,944	-£26,526	-£43,371	-£47,971	-£64,338
medium	£150	£4,601	-£13,080	-£27,721	-£23,173	-£41,922
small	£134	£4,079	-£7,589	-£15,573	-£12,199	-£25,003

Table 5.2.14. LFA grazing, Northern Ireland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	£1,293	-£12,834	-£22,767	-£64,814	-£81,993	-£91,084
Medium	£815	-£7,014	-£10,318	-£50,184	-£59,876	-£63,184
Small	£349	-£3,881	-£3,932	-£16,037	-£21,186	-£20,897

Table 5.2.15. LFA grazing, Scotland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£700	£8,893	-£52,956	-£96,427	-£90,747	-£144,922
large	£311	-£2,024	-£27,407	-£51,842	-£55,625	-£80,816
medium	£152	£237	-£8,866	-£37,356	-£37,254	-£46,186
small	£989	-£672	-£9,449	-£21,833	-£23,152	-£31,754

Table 5.2.16. LFA grazing, Wales

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£231	-£15,701	-£14,415	-£54,177	-£64,870	-£62,486
large	-£35	-£9,555	-£15,501	-£23,403	-£35,170	-£40,181
medium	-£98	-£8,329	-£7,607	-£17,767	-£27,257	-£25,912
small	-£6	-£2,204	-£6,081	-£11,528	-£14,387	-£17,953

Table 5.2.17. Lowland grazing, England

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	-£6,318	-£20,291	-£55,046	-£47,229	-£66,399	-£103,659
large	£178	£1,048	-£18,169	-£24,347	-£29,708	-£46,886
medium	£210	£6,785	-£18,516	-£13,382	-£6,757	-£32,691
small	£114	£2,496	-£9,476	-£11,426	-£9,935	-£22,402

Table 5.2.18. Lowland grazing, Northern Ireland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	£300	£7,721	-£16,290	-£67,996	-£56,626	-£85,903
Medium	£284	£6,375	-£19,042	-£34,018	-£22,488	-£54,069
Small	£77	£1,450	-£6,968	-£12,589	-£10,559	-£22,129

NB. no very large farms in sample

Table 5.2.19. Lowland grazing, Scotland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£965	£29,670	-£61,509	-£127,440	-£105,909	-£195,958
large	£464	£11,734	-£31,144	-£43,159	-£36,849	-£79,208
medium	£141	£3,986	-£9,454	-£37,292	-£34,578	-£47,824
small	£339	£10,903	-£17,905	-£12,893	-£4,783	-£35,285

Table 5.2.20. Lowland grazing, Wales

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£23,067	£43,995	-£81,355	-£8,588	£14,478	-£116,772
large	£9,429	£5,981	-£37,107	-£9,044	-£13,191	-£55,857
medium	£6,323	£11,454	-£9,445	-£9,336	-£4,612	-£25,451
small	£9,210	£15,287	-£1,943	-£1,913	£4,187	-£14,470

Table 5.2.21. Mixed, England

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£786	£12,405	-£36,752	-£53,299	-£45,740	-£96,933
large	£587	£13,917	-£15,389	-£32,685	-£20,868	-£51,509
medium	£209	£2,669	-£9,375	-£18,884	-£17,961	-£30,508
small	£70	£3,165	-£5,690	-£15,311	-£13,777	-£22,019

Table 5.2.22. Mixed, Northern Ireland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	-£818	-£1,281	-£8,090	-£15,982	-£15,611	-£23,478
Medium	-£8,378	£1,558	-£19,569	-£40,212	-£27,915	-£51,012
Small	-£9,163	-£5,174	-£14,112	-£23,774	-£19,162	-£28,875

NB. no very large farms in sample

Table 5.2.23. Mixed, Scotland

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£786	£23,430	-£30,123	-£55,631	-£35,155	-£96,899
large	£84	£7,694	-£6,018	-£72,509	-£87,944	-£75,740
medium	£229	£9,767	-£12,054	-£39,953	-£34,042	-£57,942
small	£241	£7,414	-£14,823	-£19,349	-£13,687	-£35,707

Table 5.2.24. Mixed, Wales

Farm size	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
very large	£324	-£28,930	-£76,392	-£63,230	-£99,326	-£164,044
large	£479	£20,203	-£26,121	-£31,787	-£14,037	-£63,625
medium	£1,771	£2,997	-£3,316	-£16,562	-£15,445	-£22,749
small	-£22	-£87	-£2,635	-£14,469	-£19,187	-£18,037

Annex 5.3. estimated % livestock changes, by country, selected farm type & size, and scenario

Dairy

Table 5.3.1. Dairy farms, England – dairy cows

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	+11%	+86%	0%	0%	+86%	0%
Large	0%	+25%	0%	0%	+25%	0%
Medium	0%	+4%	0%	0%	+4%	0%
Small	0%	5%	0%	0%	+5%	0%

Table 5.3.2. Dairy farms, Northern Ireland – dairy cows

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	+50%	0%	0%	+50%	0%
Large	+11%	+33%	0%	0%	+33%	0%
Medium	0%	+20%	0%	0%	+20%	0%
Small	0%	+50%	0%	-17%	+50%	-19%

Table 5.3.3. Dairy farms, Scotland – dairy cows

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	+2%	+15%	-55%	+3%	+15%	-55%
Large	0%	0%	-34%	0%	0%	-34%
Medium	1%	+6%	-30%	1%	+6%	-30%
Small	0%	+5%	-38%	-1%	+5%	-38%

Table 5.3.4. Dairy farms, Wales – dairy cows

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	+2%	+22%	-79%	+3%	+16%	-82%
Large	+1%	+13%	-86%	+1%	-1%	-88%
Medium	+1%	+18%	-84%	+1%	+12%	-86%
Small	+1%	+14%	-81%	+1%	+5%	-83%

LFA Grazing farms

Table 5.3.5. LFA grazing, England – beef

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	+1%	-73%	-17%	0%	-100%
Large	0%	+19%	-100%	-97%	+21%	-100%
Medium	0%	0%	0%	-8%	0%	-1%
Small	0%	0%	0%	-10%	0%	0%

Table 5.3.6. LFA grazing, England – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	-99%	-98%	0%	-99%	-98%
Large	0%	-100%	-3%	0%	-99%	-50%
Medium	0%	-94%	-94%	0%	-94%	-95%
Small	0%	-39%	-39%	+22%	-42%	-49%

Table 5.3.7. LFA grazing, Northern Ireland – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	0%	-42%	-34%	0%	-42%	-34%
Medium	0%	-12%	-12%	0%	-12%	-12%
Small	0%	0%	0%	0%	0%	0%

NB. no very large farms in NI FBS sample, small sample sizes overall and no beef enterprise on representative farm LFA grazing farms

Table 5.3.8. LFA grazing, Scotland – beef

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	+10%	-92%	-1%	+6%	-92%
Large	0%	+15%	-76%	-55%	+10%	-76%
Medium	0%	+9%	-69%	-61%	+9%	-69%
Small	0%	+3%	-49%	-13%	+6%	-49%

Table 5.3.9. LFA grazing, Scotland – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	-98%	-97%	0%	-98%	-100%
Large	0%	-48%	-48%	-65%	-88%	-67%
Medium	0%	-99%	-99%	-43%	-100%	-100%
Small	0%	-2%	0%	0%	-38%	-23%

Table 5.3.10. LFA grazing, Wales – beef

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	>+300%	0%	0%	>+300%	0%
Large	0%	0%	-100%	0%	0%	-100%
Medium	+33%	+55%	-66%	+33%	>+300%	-66%
Small	0%	0%	-100%	0%	0%	-100%

Table 5.3.11. LFA grazing, Wales – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	-3%	0%	0%	-8%	0%
Large	0%	-17%	-2%	0%	-17%	-2%
Medium	0%	0%	0%	0%	0%	0%
Small	0%	-96%	0%	0%	-53%	0%

Lowland grazing farms

Table 5.3.12. Lowland grazing, England – beef

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	+20%	+33%	-100%	+20%	+33%	-100%
Large	0%	0%	-91%	0%	0%	-89%
Medium	0%	0%	-19%	0%	0%	-16%
Small	0%	0%	0%	0%	0%	0%

Table 5.3.13. Lowland grazing, England – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	-99%	-37%	0%	-99%	-47%
Large	0%	-99%	0%	0%	-99%	-3%
Medium	0%	-100%	-99%	0%	-100%	-99%
Small	0%	-60%	-8%	0%	-78%	-13%

Table 5.3.14. Lowland grazing, Northern Ireland – beef

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	0%	0%	-6%	0%	0%	-6%
Medium	0%	0%	0%	0%	0%	0%
Small	0%	0%	0%	9%	9%	9%

NB. no very large farms in NI FBS sample

Table 5.3.15. Lowland grazing, Northern Ireland – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Large	0%	0%	0%	-100%	-100%	-100%
Medium	0%	0%	0%	-100%	-100%	-97%
Small	0%	-95%	-83%	-89%	-94%	-77%

NB. no very large farms in NI FBS sample

Table 5.3.16. Lowland grazing, Scotland – beef

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very large	0%	0%	-100%	0%	0%	-100%
Large	0%	0%	-65%	0%	0%	-81%
Medium	0%	0%	-100%	0%	0%	-100%
Small	0%	0%	-62%	0%	0%	-100%

Table 5.3.17. Lowland grazing, Scotland – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very large	0%	-99%	-99%	0%	-99%	-99%
Large	0%	0%	-51%	0%	0%	-51%
Medium	0%	-98%	-96%	0%	-98%	-96%
Small	0%	0%	-35%	0%	0%	-38%

Table 5.3.18. Lowland grazing, Wales – beef

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	0%	0%	0%	0%	0%
Large	0%	0%	-55%	+55%	0%	-33%
Medium	0%	0%	-6%	6%	0%	-6%
Small	0%	0%	-66%	66%	0%	-58%

Table 5.3.19. Lowland grazing, Wales – sheep

Farm type	FTA+	WTO+	UTL+	FTA-	WTO-	UTL-
Very Large	0%	-98%	-10%	0%	-98%	-10%
Large	0%	-78%	-39%	0%	-79%	-51%
Medium	0%	-78%	-65%	0%	-78%	-67%
Small	0%	-100%	-13%	0%	-100%	-30%

Annex 5.4. ScotFarm assumptions and caveats

Introduction

ScotFarm is implemented using GAMS (General Algebraic Modelling System), a piece of specialist software originating from the World Bank in the 1980s and now commonly used for a range of modelling applications, including LP models of agriculture.[1] Data can be included directly in the GAMS coding script or imported from an external file (including Excel).

As with any model, ScotFarm necessarily invokes several assumptions. Some of these are common to all linear programming (LP) models, others are specific to how ScotFarm is configured to characterise the circumstances facing a particular farm. These assumptions draw on literature, expert opinion and the Farm Business Survey (FBS), and are summarised briefly below.

Generic assumptions

In common with all LP models, ScotFarm invokes several generic assumptions. First, that the contribution of each decision variable to the objective function is linearly proportional to the level of the decision variable (i.e. no economies of scale). Second, that the contribution of each decision variable is additive, meaning no multiplicative interactions between activities (i.e. no economies of scope). Third, decision variables are divisible and hence able to take any fractional value (i.e. no resource "lumpiness").

Relaxation of these assumptions is possible but involves additional complexity. For example, economies of scale and scope have been accommodated to a limited extent through stepwise specification of some separate activities. However, if significant non-linearities exist, the model will not accurately capture them and hence results may under or over-estimate actual changes in production.

Similarly, although ScotFarm allows some variation in parameter values for given activities across different farm circumstances, input:output relationships are assumed to be deterministic rather than stochastic. This neglects year-on-year variation due to, for example, weather conditions, which could influence production decisions if farmers were not risk-neutral (which they are assumed to be). Again, such assumptions could be relaxed but have not been due to the additional modelling complexity and data needs of doing so.

Dynamics and Time Horizons

Agricultural production cycles typically span more than one year. For example, dairy calves have to be born and reared (or purchased as breeding replacements) before entering the milking herd and will be replaced after around four years. Equally, activities do not occur evenly throughout the year and timing can be important for biological processes and peak-loading on labour or machinery. For example, grass yields vary by month.

This complexity is approximated within ScotFarm by explicitly differentiating sub-categories of activity by time (e.g. first vs. second silage cuts) and by running the model over successive years, with the

[1] See https://www.gams.com/

model results for one year acting as the starting position for the next (which may face different prices etc. and hence is a different model run). The starting position in the base year is taken from FBS data.

In reality, the sequencing and timing of on-farm activities may vary from year-to-year and across farms. As such, assumed scheduling may misrepresent actual resource availability and peakloading, which again may lead to under or over-estimation of production opportunities.

Production possibilities

ScotFarm is configured to mimic farm-level circumstances of either an actual farm (e.g. one farm from within the FBS) or a constructed representative farm (e.g. the average of several farms within the FBS). Currently, the production possibilities available on a particular farm are assumed to be restricted to those observed on that farm in the base year.

This reflects short-term constraints on farmers' ability to adopt new enterprises due to investment requirements for new skills and/or equipment, but also the biophysical limitations on many farms. For example, switching from beef to dairy production requires investment in a milking parlour and grazing supportive of suckler cattle may not be suitable for dairy cattle. Relaxing this assumption to allow for a wider range of production possibilities would entail consideration of investment needs and land capability (land quality is not currently explicitly modelled).

To accommodate different farm types, ScotFarm can cater for a wider range of production possibilities than typically specified for any individual farm. This wider range is based on enterprises observed across the full FBS sample and includes all of the main enterprises – but currently excludes pigs, poultry and horticulture.

Coefficient values

Production possibilities are described using technical coefficients to specify the relationship between inputs and outputs (e.g. labour required per ewe) but also their financial values (i.e. input and output prices). ScotFarm currently uses FBS data and officially reported market prices to derive base year prices, and price projections from FAPRI[2] for future years. Technical coefficients are mostly derived from literature, particularly the feed requirements of different animals and the feed value of different feedstuffs. Initial land areas, livestock numbers and stocking densities are derived from FBS data, as are milk and crop yields.

Adequately reflecting heterogeneity across farming systems is challenging, but draws on available information. For example, different milk yields are specified, with accompanying variation in feed (but not other input) requirements, to allow for a limited degree of different intensities of production on different farms, based on their observed base year milk yield.

Decision Variables

Whereas the technical and value coefficients describing production possibilities are fixed exogenously, ScotFarm allows a number of variables to be varied endogenously. One is the model objective, but most are non-negative decision variables relating to physical production activities.

[2] e.g. see https://content17.green17creative.com/media/99/files/FAPRI_UK_Brexit_Report.pdf

The decision variables essentially encompass the land, livestock and labour allocated to different enterprises. To reflect production cycle linkages, buying, selling and culling livestock of different ages are defined explicitly.

Constraints

LP models optimise an objective function (e.g. farm income) by selecting from the production possibility set subject to resource availability. ScotFarm constraints are grouped into those relating to land, to livestock, to feed, to crops, to labour and to enterprise revenues and costs. Revenues and costs simply apply prices to chosen activity levels, whilst other equations ensure that technical and resource constraints are observed. For example, that livestock feed requirements are met and that livestock numbers reflect breeding rates plus buying and selling activities.

Within the numerous constraints, most are essentially non-contentious identities. However, a few merit further comment. For example, to prevent overly abrupt shifts in cropping patterns, the area of any individual crop cannot alter by more than 50% in a single year and stocking density is constrained to be no more than double the initial value. These are arbitrary limits which could be varied if better information was available on (for example) land quality or capital constraints but are necessary to dampen rates of change and preclude extreme results.

Objective function

The objective function within ScotFarm is maximisation of Farm Business Income (FBI), currently the official preferred measure of income at the farm-level. Although farmers may not actually exhibit profit maximising behaviour, assuming that they do offers a convenient first-approximation. Moreover, alternative objective functions are harder to specify and/or to implement (e.g. risk-weighted income).

FBI is used as an indicator of financial returns to unpaid labour and capital invested for sole-trader and partnership farms (or return on shareholder capital for corporate farms). Unlike Net Farm Income (NFI), no account is taken of imputed wages or imputed rents. Other income metrics, such as NFI or Cash Income could, however, be easily used instead, yet do not fundamentally alter the pattern of results.

FBI is calculated within ScotFarm as the sum of individual enterprise gross margins plus decoupled support payments, less paid labour costs, feed costs and overhead costs.[3] Decoupled support payments and overhead costs are determined exogenously, but other elements of the calculation are determined within the model.

Results

As with all scenario analysis, presentation of the results covering a number of years presents choices. Comparisons can be made with the (static) base year or with a (dynamic) baseline derived by running the model forward under Business as Usual (BaU). Equally, comparisons can be made between model results for a single year or averaged over a number of years. The latter is currently the default within ScotFarm, with the first few and last few years of any simulation period discarded to avoid potential

[3] NB. the FBS includes labour in fixed costs and feed in variable costs, but they have been explicitly split-out in ScotFarm as important sub-categories, and hence need to be included separately in this calculation.

initiation and/or termination distortions (i.e. LP models can attempt to liquidate assets in the last time period, to maximise final profits).

Conclusions

Like any LP model, ScotFarm necessarily invokes a number of simplifying assumptions to overcome data gaps and represent production relationships. As such, model results are at best only an approximation of reality and should only be taken as indicative of how production patterns may change under different scenarios.

In particular, results are unlikely to capture the full heterogeneity of production responses across farms facing different circumstances. For example, staff skills and land quality vary somewhat across different farms, as do choices of crop varieties and livestock breeds – all of which would be expected to influence responsiveness to changing market and policy signals.

Nevertheless, by using a variety of information sources to characterise different farming systems in terms of resource requirements and production possibilities, it is possible to aid understanding of how farm-level responsiveness may vary across different discrete farm types and scenarios.

On this basis, the ScotFarm results do serve to illustrate the challenge posed by withdrawal of direct payments and changes to farmgate prices, and give some indication of likely resource allocations and production patterns within existing farm structures. Responsiveness to the pressure for the more significant structural change implied by these results is, however, more difficult to model.

In principle, the range of activities and availability of resources could be expanded for modelled farms. This would allow further exploration of the extent to which on-farm adjustments could perhaps accommodate changing policy and market signals. It would not, however, provide insights into actual structural change without somehow linking to resource usage and production volumes at the regional or sectoral level.

That is, for one farm to achieve, for example, improved economies of scale by expanding its land area, another farm would need to release the land. This highlights the need to account for spatial proximity as well as dynamic feedback mechanisms through product and factor markets, confirming the desirability of modelling systems which integrate across different scales.

ANNEXES CHAPTER 7: FARM HOUSEHOLD ANALYSIS

Annex 7.1. FBS sample sizes (number of farms), by country and farm type and age

Number of Farms	Cereals	Dairy	Mixed	Specialist beef	Specialist sheep	Pigs
England	287	235	165	25	48	59
34-44 years	30	36	17	1	3	5
45-54 years	68	89	54	8	11	28
55-64 years	102	72	60	9	21	16
>64 years	87	38	34	7	13	10
Northern Ireland	11	103	14	40	27	10
34-44 years	-	11	1	5	2	1
45-54 years	6	25	3	6	7	4
55-64 years	3	36	2	13	12	3
>64 years	2	31	8	16	6	2
Scotland	60	38	-	102	38	-
34-44 years	2	4	-	9	2	-
45-54 years	14	23	-	32	7	-
55-64 years	24	8	-	31	14	-
>64 years	20	3	-	30	15	-
Wales	8	95	11	14	131	-
34-44 years	1	9	1	1	10	-
45-54 years	1	35	3	2	31	-
55-64 years	-	30	3	3	43	-
>64 years	6	21	4	8	47	-

* – signifies no farms

Annex.7.2. Farm business income by country and scenario

Country/Scenario	Base	FTA+	FTA-	UTL+	UTL-	WTO+	WTO-
England	38 920	38 081	16 493	18 600	-4 074	60 395	37 947
NI	28 009	28 122	7 639	4 969	-17 262	36 852	14 586
Scotland	22 376	22 335	-7 792	-6 792	-38 419	32 589	1 018
Wales	22 284	22 692	3 993	2 616	-16 815	41 134	21 736
All UK	**32 973**	**32 528**	**10 148**	**11 082**	**-12 476**	**50 945**	**27 532**

Annex.7.3. Farm business income by farm types and scenario

Farm types	Base	FTA+	FTA-	UTL+	UTL-	WTO+	WTO-
Dairy	60 025	61 761	41 251	12 995	-8 334	152 228	131 187
Cereals	39 133	37 982	4 566	31 909	-2 474	41 728	7989
General Cropping	64 425	61 352	25 825	53 182	16 744	64 697	28 699
LFA Grazing Livestock	18 644	18 515	-3 160	-1 697	-24 926	18 098	-5 191

Lowland Grazing Livestock	17 296	17 177	-1 394	-6 375	-26 223	21 126	1 275
Mixed	23 063	22 326	200	-724	-24 211	34 481	11 164
Specialist Pigs	47 291	47 060	39 134	25 360	16 675	154 262	145 392
Specialist Beef	17 742	17 759	-3 870	-9 025	-31 837	24 861	2 061
Specialist Sheep	18 718	18 374	-230	4 592	-15 884	10 794	-9 796

Annex 7.4. Cost of capital and family labour income by country

Country	**Average of Family labour*min agric wage (£)**	**Average of 5% return on capital invested in non land assets (£)**	**Total Cost (£)**
England	25 112	29 583	54 694
NI	24 419	10 889	35 308
Scotland	31 432	21 059	52 492
Wales	26 905	18 305	45 210
All UK	**26 368**	**24 057**	**50 425**

Annex 7.5. Cost of capital and family labour income by country

Farm types	**Average of Family labour*min agric wage (£)**	**Average of 5% return on capital invested in non land assets (£)**	**Total Cost**
Cereals	20 677	30 170	50 847
Dairy	33 848	28 315	62 163
General cropping	25 526	44 105	69 631
LFA grazing livestock	25 949	15 814	41 762
Mixed	26 730	25 218	51 948
Specialist pigs	23 174	35 465	58 638
Specialist beef	47 721	27 923	75 644
Specialist sheep	44 118	19 612	63 729