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Short Communication

Market concentration and the healthiness of packaged food and non-alcoholic beverage sales across the European single market

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Abstract

Objective: To assess the relationship between market concentration and diversity, as indicators of market structure, and the healthiness of food and beverage sales across Europe.

Design: Market share (MS) data per country were used to calculate market concentration, assessed by the four-firm concentration ratio and market diversity, and by the number of companies with ≥ 1 % MS and the number of companies uniquely present in one European country. The healthiness of food sales was assessed by applying the NOVA classification (level of processing). Simple and multiple linear regressions were performed to assess the relationship between market concentration, diversity and the healthiness of food and beverage sales.

Setting: The European single market.

Participants: The twenty-seven European single market member states for which Euromonitor sales data were available at the most fine-grained Euromonitor packaged food and non-alcoholic beverage product subcategory level.

Results: Increased market concentration with a country and a product category fixed effect significantly predicted increased sales of ultra-processed packaged food products. There was insufficient data variability in the level of processing of non-alcoholic beverage product categories to formulate conclusions for non-alcoholic beverages. Increased market diversity in turn significantly predicted reduced country-level sales of ultra-processed products.

Conclusions: The results indicated a relationship between market structure and the healthiness of packed food products sold on the European market. However, more research with detailed nutritional data is warranted to document and quantify this interaction.

Keywords Europe Food industry Food environments Food supply Market structure Market power NOVA

Food environments are defined as 'the collective physical, economic, policy and sociocultural surroundings, opportunities and conditions that influence people's food and beverage choices and nutritional status'⁽¹⁾. Currently, these environments are characterised by easily available unheal-thy food products^(2–4) with ultra-processed foods contributing to 10% up to 51% of the purchased dietary energy across Europe⁽⁵⁾. Ultra-processed foods are products such as soft drinks and confectionery that contain substances that are not commonly found at home⁽⁶⁾. A growing body of literature shows an association between overweight and the consumption of such ultra-processed foods^(4,5,7,8).

Nonetheless, ultra-processed foods are extensively promoted, with markets expanding and several political strategies being used to protect ultra-processed food markets^(9,10).

Market structure describes the degree at which competition takes place between different companies for specific goods and services within (product) markets^(11,12). A key metric to assess the market structure and power of companies is market concentration⁽¹³⁾. When concentration increases, this translates into an increasing part of the market being held by a decreasing number of companies^(4,14). Other market structure indicators, measuring the market



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diversity, are the number of companies with ≥ 1 % market share (MS) and the number of unique companies having presence in only one European country⁽¹⁴⁾.

Across countries in Europe, packaged food and non-alcoholic beverage product markets have shown to be moderately to highly concentrated with a low number of unique companies and companies with $\geq 1 \% MS^{(14)}$. While the food industry publicly positions itself as part of the solution to create healthier food environments^(15,16), they at the same time shape markets in ways that fit their private interests⁽¹¹⁾. High levels of market concentration and reduced diversity may provide dominant companies with the opportunity to shape markets in ways that benefit them financially and economically (e.g. through the increased sales of ultra-processed foods), something that does not benefit population health^(3,4,11,12,17-19). Examples of how the food industry may influence food environments include the framing of policy debates, intensive marketing, nutritional positioning (i.e. focus on single nutrients instead of whole foods, an approach that could promote the sales of heavily processed foods), focus on individual responsibility and unenforceable self-regulatory codes^(4,15,16). Nonetheless, research assessing the influence of market structure on food environments remains limited.

This study sets out to assess whether market structure, assessed by levels of market concentration and diversity within the packaged food and non-alcoholic beverage industry across European countries, is associated with the healthiness of products sold, measured by the proportion of sales of ultra-processed food products according to the NOVA classification.

Methods

The Euromonitor International Passport database was used to obtain MS data per European single market member state, per packaged food and drink product category and per year⁽²⁰⁾. Data were obtained at the most finegrained Euromonitor product categorisation level over the period 2009–2018. For Cyprus, Iceland, Liechtenstein, Luxembourg and Malta, no Euromonitor data were available. A total of twenty-seven European countries were included in the analysis.

Market concentration

Levels of market concentration and its changes over time (2009–2018) were assessed by calculating the four firm concentration ratio (CR4) per country for fourteen packaged food product markets and eight non-alcoholic beverage product markets (Table 1; Annex 1). The CR4 is calculated by combining the MS of the top four firms per country active within a product market. The higher the CR4, the more concentrated the product market. CR4

values below 40 are considered to represent a competitive market. Values above 40 are considered to represent markets with limited competition and above 60 limited competition with potential dominant firms⁽²¹⁾.

The number of companies with ≥ 1 % MS and the number of unique companies per country were assessed to estimate levels of diversity within packaged food and non-alcoholic beverage product markets. Unique companies were defined as companies having presence in only one European single market member state. Similar to previous research, the higher the number of companies with ≥ 1 % MS and unique companies, the more diverse the industry was assumed to be⁽¹⁴⁾.

Products sold

To assess the proportion of sales coming from ultra-processed products, the NOVA classification⁽⁶⁾ was applied to the most fine-grained Euromonitor product subcategory sales data within abovementioned packaged food and non-alcoholic beverage product categories. An overview of how the Euromonitor product subcategories were classified according to the NOVA classification can be found in Annex 1. For five countries (Croatia, Estonia, Latvia, Lithuania and Slovenia), data were only available for the most fine-grained product subcategories within eight (out of the twenty-two) Euromonitor product categories ('Baked Goods', 'Concentrates', 'Dairy', 'Energy Drinks'; 'Ice Cream and Frozen Desserts', 'RTD Coffee', 'Rice, Pasta and Noodles' and 'Sports Drinks').

The NOVA classification makes a distinction between products based on the level of processing, namely nonultra-processed (unprocessed/minimally processed foods, processed culinary ingredients and processed foods) and ultra-processed products⁽⁶⁾. Per Euromonitor product category, the proportion of sales coming from ultra-processed subcategories was calculated by expressing the ultra-processed sales per country and product category on the total sales within the same country and product category. Finally, also the change over the past 10 years (2009– 2018) of the proportion of sales coming from ultraprocessed products was assessed.

The relationship between market concentration, diversity and healthiness of packaged food and drink products sold across European countries

Analyses were conducted separately for packaged food and non-alcoholic beverage product categories. A multiple linear regression was calculated across selected countries and product categories to assess whether and to what extent market concentration measured by the CR4 influences the proportion of sales of ultra-processed products. The product categories containing 100% ultraprocessed products were removed from the analysis. Ś

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 Table 1
 The proportion of sales from ultra-processed products (NOVA) and levels of market concentration according to the four firm concentration ratio (CR4) per country and product category. Euromonitor data 2018

Country Asia Specia			ality Baked		Breakfast Cereals		Carbonates		Concentrates		Confectionary		Dairy		Energy Drinks		Ice Cream and Frozen Desserts		Juice		Processed Fruit and	
	Drir	nks														ks	Dess	serts			Veget	ables
	NOVA	CR4	NOVA		NOVA	CR4	NOVA		NOVA	CR4	NOVA	CR4	NOVA	CR4	NOVA	CR4	NOVA	CR4	NOVA		NOVA	
Austria			86	8	100	62	100	70	100	55	100	58	36	37	100	70	100	76	61	50	23	49
Belgium			99	7	99	63	100	77	100	50 54	100	38	42	28	100	68	100	50	68	32	23	26
Bulgaria			95	20	100	74	100	77	100		100	54 56	12	26	100	81 94	100	87 94	97	47	24	46
Croatia			100 98	20 22	06	43	100	81 76	100	63 59	100		17	62 39	100	94 49	100		00	69	10	65
Czech Republic			90 99	22	96	71	100	76 71	100 100	63	100	70 46	31 29	59 64	100	49 84	100	75 51	90 73	52 47	16 35	36 25
Denmark			100	-	68	58 48	100	87	100	60	100	61	13	65	100 100	85	100 100	83	13	66	- 35	40
Estonia Finland			98	64 35	64	40 39	100	07 72	100	45	100	74	37	53	100	65 73	100	оз 83	84	60	25	30
France	100	84	90	8	95	70	100	82	100	45 59	100	48	32	38	100	84	100	64	48	48	25	29
	100	38	100	16	95	55	100	56	100	34	100	40	48	14	100	66	100	47	88	26	23	23
Germany Greece	100	30	93	12	85	68	100	84	100	77	100	71	21	35	100	91	100	70	97	68	8	45
			99	7	93	47	100	82	100	41	100	53	33	34	100	78	100	54	97	58	8	25
Hungary			98	24	93 74	68	100	86	100	67	100	75	42	34	100	93	100	73	60	40	34	57
Ireland Italy	100	91	90 97	24 11	100	80	100	67	100	57	100	61	35	29	100	93 88	100	23	95	40	10	30
Latvia	100		100	50	100	81	100	68	100	78	100	69	10	62	100	85	100	75		76	10	65
Lithuania			100	43		68		84	100	57		60	10	66	100	54	NA	69		56		49
Netherlands	100	76	99	11	69	50	100	63	100	62	100	37	41	30	100	76	100	71	78	43	26	43
Norway	100		86	32	69	62	100	89	100	85	100	72	28	86	100	81	100	90	50	53	20	25
Poland			94	5	96	60	100	77	100	58	100	47	31	35	100	76	100	66	79	61	8	36
Portugal	100	58	99	9	87	56	100	79	100	52	100	43	36	49	100	57	100	76	90	53	10	18
Romania	100	00	98	9	100	68	100	66	100	40	100	66	28	48	100	72	100	63	100	49	11	38
Slovakia			99	16	97	72	100	67	100	42	100	69	38	35	100	64	100	67	93	48	15	35
Slovenia			100	32		43		88	100	66		57	10	54	100	84	100	68		69		47
Spain			99	21	99	49	100	80	100	79	100	40	41	34	100	65	100	56	88	41	9	21
Sweden			94	42	78	44	100	85	100	74	100	58	20	60	100	83	100	65	77	59	29	24
Switzerland			93	5	99	42	100	75	100	43	100	28	28	26	100	67	100	54	67	34	27	17
United Kingdom	100	12	93	28	84	60	100	80	100	57	100	66	54	21	100	87	100	46	45	43	44	35
	Proce	essed					Deer		Disc	Deete	Sau	ces,	0						Swe Biscu			
	Proce Meat Sea	tand	RTD (Coffee	RTD	Tea	Read mea		Rice, I and No			gs and	Save Sna	oury acks	So	up	Spo Drin			uits, Bars Fruit	Swe Spre	
	Meat Sea	t and food					mea	ls	and No	odles	dressin condir	gs and nents	Sna	acks			Drin	nks	Biscu Snack and F Snac	uits, Bars Fruit cks	Spre	eads
Austria	Meat Sea NOVA	t and food CR4	NOVA	CR4	NOVA	CR4	mea NOVA	ls CR4	and No	cR4	dressin condir NOVA	gs and nents CR4	Sna NOVA	CR4	NOVA	CR4	Drin	nks CR4	Biscu Snack and F Snac NOVA	uits, Bars Fruit cks	Spre NOVA	cR4
Austria	Meat Sea NOVA 11	t and food CR4 28	NOVA 100	CR4 74	NOVA 100	CR4 67	mea NOVA 99	CR4 44	and No NOVA 6	CR4 39	dressin condir NOVA 89	rgs and nents CR4 49	Sna NOVA 70	CR4 54	NOVA 100	CR4 76	Drin NOVA 100	nks CR4 72	Biscu Snack and F Snac NOVA 95	uits, Bars Fruit cks CR4 41	Spre NOVA 87	CR4 66
Belgium	Meat Sea NOVA 11 23	t and food CR4 28 17	NOVA 100 100	CR4 74 81	NOVA 100 100	CR4 67 72	mea NOVA 99 93	CR4 44 23	and No NOVA 6 3	CR4 39 33	dressin condir NOVA 89 90	gs and nents CR4 49 41	Sna NOVA 70 88	CR4 54 53	NOVA 100 100	CR4 76 76	Drin NOVA 100 100	CR4 72 72	Biscu Snack and F Snac NOVA 95 99	uits, Bars Fruit cks CR4 41 38	Spre NOVA 87 93	eads CR4 66 43
	Meat Sea NOVA 11	t and food CR4 28	NOVA 100	CR4 74	NOVA 100	CR4 67	mea NOVA 99	CR4 44	and No NOVA 6	CR4 39	dressin condir NOVA 89	rigs and nents CR4 49	Sna NOVA 70	CR4 54	NOVA 100	CR4 76	Drin NOVA 100	nks CR4 72	Biscu Snack and F Snac NOVA 95	uits, Bars Fruit cks CR4 41	Spre NOVA 87	CR4 66
Belgium Bulgaria	Meat Sea NOVA 11 23	cR4 28 17 61	NOVA 100 100 100	CR4 74 81 74	NOVA 100 100	CR4 67 72 66	mea NOVA 99 93	CR4 44 23 54	NOVA 6 3	CR4 39 33 43	dressin condir NOVA 89 90	gs and nents CR4 49 41 39	Sna NOVA 70 88	CR4 54 53 32	NOVA 100 100	CR4 76 76 85	Drin NOVA 100 100	CR4 72 72 77	Biscu Snack and F Snac NOVA 95 99	uits, Bars Fruit cks CR4 41 38 43	Spre NOVA 87 93	eads CR4 66 43 41
Belgium Bulgaria Croatia	Meat Sea NOVA 11 23 4	t and food CR4 28 17 61 72	NOVA 100 100 100 100	CR4 74 81 74 85	NOVA 100 100 100	CR4 67 72 66 78	mea NOVA 99 93 91	CR4 44 23 54 47	NOVA 6 3 1 0	CR4 39 33 43 49	dressin condir NOVA 89 90 73	gs and nents CR4 49 41 39 65	Sna NOVA 70 88 64	CR4 54 53 32 38	NOVA 100 100 100	CR4 76 76 85 89	Drin NOVA 100 100 100 100	CR4 72 72 77 77 79	Biscu Snack and F Snac NOVA 95 99 95	uits, Bars Fruit cks CR4 41 38 43 59	Spre NOVA 87 93 63	eads CR4 66 43 41 50
Belgium Bulgaria Croatia Czech Republic	Meat Sea NOVA 11 23 4 29	CR4 28 17 61 72 39	NOVA 100 100 100 100 100	CR4 74 81 74 85 85	NOVA 100 100 100	CR4 67 72 66 78 64	mea NOVA 99 93 91 100	CR4 44 23 54 47 53	and No NOVA 6 3 1 0 21	CR4 39 33 43 49 37	dressin condir NOVA 89 90 73 80	gs and nents CR4 49 41 39 65 44	Sna NOVA 70 88 64 88	CR4 54 53 32 38 42	NOVA 100 100 100	CR4 76 76 85 89 84	Drin NOVA 100 100 100 100	CR4 72 72 77 79 93	Biscu Snack and F Snack 95 99 95 93	uits, Bars Fruit cks CR4 41 38 43 59 62	Spre NOVA 87 93 63 57	CR4 66 43 41 50 43
Belgium Bulgaria Croatia Czech Republic Denmark Estonia Finland	Meat Sea NOVA 11 23 4 29 19 8	CR4 28 17 61 72 39 35 56 49	NOVA 100 100 100 100 100 100 100	CR4 74 81 74 85 87 85 83 67	NOVA 100 100 100 100 100	CR4 67 72 66 78 64 68 94 57	mea NOVA 99 93 91 100 98 98	CR4 44 23 54 47 53 43 49 53	and No NOVA 6 3 1 0 21 13 0 13	CR4 39 33 43 49 37 23 31 37	dressin condir NOVA 89 90 73 80 89 85	gs and nents CR4 49 41 39 65 44 45 32 43	Sna NOVA 70 88 64 88 78 78 79	CR4 54 53 32 38 42 54 46 53	NOVA 100 100 100 100 100	CR4 76 85 89 84 70 64 54	Drin 100 100 100 100 100 100 100 100	CR4 72 72 77 79 93 80 92 77	Biscu Snack and F Snack 99 95 99 95 93 68	uits, Bars Fruit cks CR4 41 38 43 59 62 38 49 54	Spre NOVA 87 93 63 57 78 47	CR4 66 43 41 50 43 54 43 54 43 45
Belgium Bulgaria Croatia Czech Republic Denmark Estonia Finland France	Meat Sea NOVA 11 23 4 29 19 8 8 12	CR4 28 17 61 72 39 35 56 49 24	NOVA 100 100 100 100 100 100 100 100	CR4 74 81 74 85 87 85 83 67 92	NOVA 100 100 100 100 100 100	CR4 67 72 66 78 64 68 94 57 65	mea NOVA 99 93 91 100 98 98 78	CR4 44 23 54 47 53 43 49 53 34	and No 6 3 1 0 21 13 0 13 4	CR4 39 33 43 49 37 23 31 37 31 37 54	dressin condir NOVA 89 90 73 80 89 80 89 85 86	gs and nents CR4 49 41 39 65 44 45 32 43 40	Sna NOVA 70 88 64 88 78 78 79 77	CR4 54 53 32 38 42 54 46 53 45	NOVA 100 100 100 100 100 100	CR4 76 76 85 89 84 70 64 54 76	Drin 100 100 100 100 100 100 100 100 100	CR4 72 72 77 79 93 80 92 77 86	Biscu Snack and F Snac 99 95 93 68 88 88	uits, Bars Fruit cks CR4 41 38 43 59 62 38 49 54 50	Spre NOVA 87 93 63 57 78 47 75	CR4 66 43 41 50 43 54 43 43 45 56
Belgium Bulgaria Croatia Czech Republic Denmark Estonia Finland	Meat Sea NOVA 11 23 4 29 19 9 9 19 8 12 36	t and food CR4 28 17 61 72 39 35 56 49 24 10	NOVA 100 100 100 100 100 100 100 100 100	CR4 74 81 74 85 87 85 83 67 92 35	NOVA 100 100 100 100 100 100 100	CR4 67 72 66 78 64 68 94 57 65 44	mea NOVA 99 93 91 100 98 98 78 96	CR4 44 23 54 47 53 43 49 53 34 38	and No 6 3 1 0 21 13 0 13 4 1	CR4 39 33 43 49 37 23 31 37 23 31 37 54 30	dressin condir NOVA 89 90 73 80 89 85 86 85 86 82	gs and nents CR4 49 41 39 65 44 45 32 43 40 44	Sna NOVA 70 88 64 88 78 78 79 77 74	CR4 54 53 32 38 42 54 46 53 45 40	NOVA 100 100 100 100 100 100 100	CR4 76 76 85 89 84 70 64 54 76 66	NOVA 100 100 100 100 100 100 100 100 100	CR4 72 72 77 79 93 80 92 77 86 24	Biscu Snack and F Snack 99 95 93 68 88 88 88 88	uits, Bars Fruit cks CR4 41 38 43 59 62 38 49 54 50 26	Spre NOVA 87 93 63 57 78 47 75 76	CR4 66 43 41 50 43 54 43 45 56 48
Belgium Bulgaria Croatia Czech Republic Denmark Estonia Finland France Germany Greece	Meat Sea NOVA 11 23 4 29 19 29 19 8 12 36 34	t and food CR4 28 17 61 72 39 35 56 49 24 10 34	NOVA 100 100 100 100 100 100 100 100 100	CR4 74 81 74 85 87 85 83 67 92 35 85	NOVA 100 100 100 100 100 100 100 100	CR4 67 72 66 78 64 68 94 57 65 44 82	mea NOVA 99 93 91 100 98 98 78 96 94	CR4 44 23 54 47 53 43 49 53 34 38 47	and No 6 3 1 0 21 13 0 13 4 1 1	CR4 39 33 43 49 37 23 31 37 23 31 37 54 30 55	dressin condir NOVA 89 90 73 80 89 80 89 85 86 82 93	gs and nents CR4 49 41 39 65 44 45 32 43 40 44 57	Sna NOVA 70 88 64 88 78 79 77 74 91	CR4 54 53 32 38 42 54 46 53 45 40 51	NOVA 100 100 100 100 100 100 100 100	CR4 76 76 85 89 84 70 64 54 76 66 100	NOVA 100 100 100 100 100 100 100 100 100 10	CR4 72 72 77 79 93 80 92 77 86 24 99	Bisct Snack and F Snack 95 99 95 93 68 88 88 88 88 88 88 88 88 95	uits, Bars Fruit cks CR4 41 38 43 59 62 38 49 54 50 26 56	Spre NOVA 87 93 63 57 78 47 75 76 68	CR4 66 43 41 50 43 54 43 54 43 45 56 48 28
Belgium Bulgaria Croatia Czech Republic Denmark Estonia Finland France Germany Greece Hungary	Meat Sea 11 23 4 29 19 19 8 8 12 36 34 13	t and food 28 17 61 72 39 35 56 49 24 10 34 28	NOVA 100 100 100 100 100 100 100 100 100 10	CR4 74 81 74 85 87 85 83 67 92 35 85 55	NOVA 100 100 100 100 100 100 100 100 100	CR4 67 72 66 78 64 68 94 57 65 44 82 68	mea NOVA 99 93 91 100 98 78 98 78 96 94 86	CR4 44 23 54 47 53 43 49 53 34 38 47 35	and No 6 3 1 0 21 13 0 13 4 1 1 1 1	CR4 39 33 43 49 37 23 31 37 54 30 55 31	dressin condir NOVA 89 90 73 80 89 85 86 82 93 81	gs and nents CR4 49 41 39 65 44 45 32 43 40 44 57 41	Sna NOVA 70 88 64 88 78 79 77 74 91 77	CR4 54 53 32 38 42 54 46 53 45 40 51 39	NOVA 100 100 100 100 100 100 100 100 100	CR4 76 76 85 89 84 70 64 54 76 66 100 84	Nova 100 100 100 100 100 100 100 100 100 10	CR4 72 72 77 79 93 80 92 77 86 24 99 64	Bisct Snack and F Snack 95 99 95 93 68 88 88 88 88 88 88 88 95 94	Lits, Bars Fruit cks CR4 41 38 43 59 62 38 49 54 50 26 56 43	Spre NOVA 87 93 63 57 78 47 75 76 68 48	CR4 66 43 41 50 43 54 43 54 43 45 56 48 28 30
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Belgium Bulgaria Croatia Czech Republic Denmark Estonia Finland France Germany Greece Hungary Ireland Italy	Meat Sea 11 23 4 29 19 19 8 8 12 36 34 13	t and food CR4 28 17 61 72 39 35 56 49 24 10 34 28 57 19	NOVA 100 100 100 100 100 100 100 100 100 10	CR4 74 81 74 85 85 85 83 67 92 35 85 55 74 63	NOVA 100 100 100 100 100 100 100 100 100	CR4 67 72 66 78 64 68 94 57 65 44 82 68 65 52	mea NOVA 99 93 91 100 98 78 98 78 96 94 86	CR4 44 23 54 47 53 43 49 53 34 38 47 35 34 29	and No NOVA 6 3 1 0 21 13 0 13 4 1 1 11 38 0	CR4 39 33 43 49 37 23 31 37 54 30 55 31 44 33	dressin condir NOVA 89 90 73 80 89 85 86 82 93 81	gs and nents CR4 49 41 39 65 44 45 32 43 40 44 57 41 44 37	Sna NOVA 70 88 64 88 78 79 77 74 91 77	CR4 54 53 32 38 42 54 46 53 45 40 51 39 58 38	NOVA 100 100 100 100 100 100 100 100 100	CR4 76 76 85 89 84 70 64 54 76 66 100 84 72 63	Drin 100 100 100 100 100 100 100 100 100 10	CR4 72 72 77 93 80 92 77 86 24 99 64 90 82	Bisct Snack and F Snack 95 99 95 93 68 88 88 88 88 88 88 88 95 94	uits, Bars Fruit cks CR4 41 38 43 59 62 38 49 54 54 54 54 54 54 49 49 49 49 49 49 49 49 49 49 49 49 49	Spre NOVA 87 93 63 57 78 47 75 76 68 48	CR4 66 43 41 50 43 54 43 54 43 45 56 48 28 30 49 51
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Red indicates CR4 values >60 % and proportion of sales >80 %. Yellow indicates CR4 values >40 %.

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Predictor variable	Regression	95 % CI
Intercept CR4 Country fixed effect Product category fixed effect	17-03 0-13 Yes Yes	9·21, 24·85 0·002, 0·25

No significant correlations were detected between changes over the past 10 years in levels of market concentration and the proportion of sales of ultra-processed products (data not shown).

food Among packaged products these were 'Confectionary', 'Ice Cream and Frozen Desserts' and 'Soup'. Among the non-alcoholic beverages, all product categories were 100% ultra-processed apart from 'Juice'. Consequently, there was not enough variability in the model and no multiple linear regression was calculated for non-alcoholic beverages. The final multiple regression model for packaged foods included the CR4, a country fixed effect and a category fixed effect as predictor variables (Table 2). The product category 'Rice, Pasta and Noodles' was used as reference category as, on average, this was the least processed product category.

Simple linear regression analyses were performed to determine whether the number of companies per country with ≥ 1 % MS and the number of unique companies within packaged food and non-alcoholic beverage product markets significantly predicted the proportion of sales from ultra-processed products at country level in 2018.

Correlations of changes over time in the proportion of sales from ultra-processed products with changes in levels of market concentration were assessed. *R*-values >0.5 were considered to represent a strong correlation. *P*-values <0.05 were considered statistically significant.

All analyses were performed using Microsoft Excel and SAS 9.4 (2018).

Results

The product categories 'Asian Speciality Drinks', 'Carbonates', 'Concentrates', 'Confectionary', 'Energy Drinks', 'Ice Cream and Frozen Desserts', 'RTD Coffee', 'RTD Tea', 'Soup' and 'Sports Drinks' were for 100% ultra-processed across all European countries. Within the remaining twelve product categories, the proportion of ultra-processed sales varied per country. The level of market concentration, as measured by the CR4, varied per product category and country (Table 1). Several companies were included in the CR4 in multiple countries and across multiple product categories. Detailed information on the companies included in the CR4 of more than one product category as well as the number of countries in which the company was within the CR4 of this product category can be found in Annex 3.

Market concentration and sales of less healthy products

A multiple linear regression model including the CR4, a country fixed effect and a product category fixed effect (Table 2) was significant and explained 93% of the variance in sales of ultra-processed packaged foods ($F(37\ 219) = 78\cdot13, P < 0.0001$).

The CR4 (P=0.046), the country (P=0.004) and the product category (P < 0.0001) were all significant predictors of sales of ultra-processed packaged food products. It was estimated that the proportion of sales of ultra-processed packaged food products increased with 0.13 for a one unit increase of the CR4, in addition to the increase caused by product category or the decrease caused by country, relative to the product category 'Rice, Pasta and Noodles' and the United Kingdom as reference country (Table 2, Annex 2). The fixed effect estimates, together with the *P*-values and 95 % CI, per product category and per country can be found in Annex 2.

Market diversity and sales of less healthy products

The number of companies with ≥ 1 % MS and the number of unique companies per country both significantly predicted sales of ultra-processed packaged food products ($\beta = -2.73$, P = 0.004 and $\beta = -3.06$, P = 0.003, respectively). This was not the case for non-alcoholic beverages. Concretely, when per country the number of packaged food companies with ≥ 1 % MS and the number of unique packaged food companies increased, the sales of ultra-processed foods significantly decreased. Results are visually represented in Fig. 1.

Discussion

This study set out to assess if market concentration, as measured by the CR4, and market diversity, assessed by the number of companies with ≥ 1 % MS and the number of unique companies per country, can predict the proportion of sales from ultra-processed products. A multiple linear regression model with the CR4, the country and the product category as predictor variables found that all three predictor variables significantly predicted the proportion of sales attributed to ultra-processed packaged food products. Increased market diversity in turn showed to significantly reduce sales of ultra-processed packaged food products but not non-alcoholic beverages. These results imply that increased market concentration, as measured by the CR4, may favour the increase in sales of ultra-processed packaged food products when taking into account both the product category and country. In contrast, increased market diversity in turn might be able to reduce sales of ultraprocessed packaged food products.

Similar to our findings, a study in Asia found that market forces, including market concentration, were significant but variable drivers of the increase in sales of

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Market concentration v. EU packaged food sales

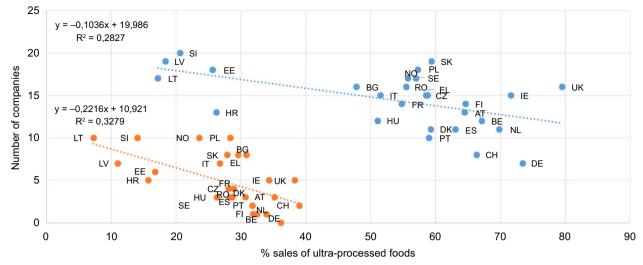


Fig. 1 Regression of sales ultra-processed packaged food products (NOVA) with the number of companies with \geq 1 % market share (MS) (blue) and the number of unique companies (orange). Countries are indicated to the right of the blue dots (the number of companies with \geq 1 % MS) and to the left of the orange dots (the number of unique companies. NA means no sales of that category in that country in 2018 according to the Euromonitor data. Empty cells are countries for which no data were available at the most detailed level of the Euromonitor product categorisation system and as such products could not be classified. , Companies with \geq 1% market share; , unique companies

ultra-processed products. This study also observed that concentration was highest in ultra-processed product markets such as soft drinks, biscuits and snack foods⁽²²⁾. This matches our finding that the product category had a strong effect in predicting sales of ultra-processed packaged food products.

A potential explanation for the decreased sales of ultraprocessed products when more companies with ≥ 1 % MS and unique companies are present on the market could be that smaller companies lack both the financial and political resources to shape food environments and undermine public health^(3,23). Nonetheless, the sales of ultra-processed products is expanding worldwide, according to a study at global level using Euromonitor data⁽⁴⁾. To increase the healthiness of food environments, the food industry would need to reduce marketing and sales of ultra-processed products. This however inherently opposes the aim to maximise profits, especially for companies that rely on the sales of ultra-processed foods^(24,25). This conflict of interest may result in the food industry resorting to political activities to protect their markets and profitability^(4,9,24), something that becomes more attainable for dominant companies in highly concentrated markets with low market diversity⁽⁹⁾.

This study documents the possible impact of market structure on the healthiness of packaged foods and nonalcoholic beverages while highlighting the importance of looking beyond food policy to improve the healthiness of food environments. Nevertheless, this study has several limitations. Levels of market concentration may be an underestimation. The Euromonitor database focuses on brand ownership rather than companies. Consequently, companies that are considered independent in Euromonitor (and for the calculation of market concentration) may still sell brands from other companies through licensing agreements. Due to the lack of nutritional data at European level, there was insufficient variability to formulate conclusions for non-alcoholic beverages. Towards the future, more research is required using country-level data and detailed nutritional information to strengthen our understanding of the nutritional implications of market structures across Europe.

In conclusion, our results suggest that increased market concentration and reduced market diversity may predict increased sales of ultra-processed packaged food products across Europe. It is therefore recommended to take into account the market structure, in addition to policy effectiveness, when developing policies to improve food environments.

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