Designing a Roadmap for Effective and Sustainable Strategies for Assessing and Addressing the Challenges of EU Agriculture to Navigate within a Safe and Just Operating Space

Investigating Firm-Level Strategic Responses to VAT reform in Animal and Plant-Based Protein Markets

Discussion paper

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Abstract

This paper analyzes the effects of a reduction in the value-added tax (VAT) rate on plant-based milk products in the Italian retail market, to assess the role of producers' strategic behaviour in shaping the expected outcomes of policies designed to encourage more sustainable food consumption patterns. We use CIRCANA retail scanner data of food purchases in all supermarkets and hypermarkets in Italy over a five-year period (March 2021-February 2026) to estimate demand for ultra-high temperature (UHT) milk and related plant-based substitutes through the random coefficient logit demand model approach (Berry et al., 1995; Nevo, 2000). Under the assumptions of a pure-strategy Nash-Bertrand equilibrium, the estimated demand parameters are used to recover the mark-up and marginal costs for each product. The demand and supply-side parameters are then employed to carry out a counterfactual simulation in which we assume the VAT rate on plant-based milk to be lowered from 22% to 10%. The results from our counterfactual simulation show that prices of all plant-based products would fall substantially after the VAT reform (from 11.6% to 15.7%) with a consequent increase in their market shares (from 21.1% to 31.6%). However, mixed results are found in terms of producers' strategic pricing reaction, with evidence of near-full price transmission in some cases, but more predominantly of partial price transmission of the VAT reduction to consumer prices. Overall, our findings stress the importance of accounting for strategic pricing behavior along the agri-food supply chain for ex-ante evaluation of policy outcomes.

Keywords: animal protein, plant-based protein, VAT reform, price-transmission, firm-strategic behaviour

JEL codes: H32, L13, Q18

1. Introduction

Cow's milk and alternative, plant-based "milks" face different consumer tax conditions in Italy. All products and services sold in the country are subject to the Value Added Tax (VAT), which falls at a flat 22% rate unless excepted (D.P.R. n. 633/1972). Essential food items considered indispensable to everyday life are taxed at a 4% rate, which includes unconcentrated and unsweetened fresh milk. Plant-based milks, such as almond, soy, oat, and other alternative milks, do not qualify for this lower VAT rate. In 2024, 50.7% of the Italian plant-based market consisted of alternative milks, which in turn held 11.5% of sales value of the overall milk purchases (inclusive of animal milks) (Good Food

Institute Europe, 2025). There are indications that this market is growing, with sales increasing 5.9% between 2023-2024 (Good Food Institute Europe, 2025).

Individuals may choose to drink plant-based milks for a variety of motivations, such as dairy intolerances or adherence to diets that do not incorporate animal products. In a 2023 survey of Italian consumers, 31% identified themselves as flexitarian (individuals looking to reduce animal product consumption without complete abstention), pescatarian, vegetarian or vegan (ProVeg International, 2024). Environmental impacts also play a role in these decisions, as the livestock sector contributes over 16% of human-led greenhouse gas emissions (ProVeg International, 2019).

The discrepancy between how animal and plant-based milks are taxed has been described as a 'VAT gap', where alternative milks are classified as beverages, as opposed to staple goods, across many European states (ProVeg International, 2019). Italy's VAT gap is the largest across the European Union at 450%, with Germany, Spain, Slovakia and Austria's discrepancies falling between 100-171% (ProVeg International, 2019). Other states, such as Belgium, Denmark, Finland, France, Ireland, the Netherlands, and the United Kingdom maintain an equal VAT for all milk types (ProVeg International, 2019).

In 2022, alternative milks demanded a 30% price premium above conventional milks in Italy (Nes et al, 2024). Their associated VAT gap means consumers of these milks pay an additional tax on what they may consider an everyday, essential food item. It may also dissuade consumers interested in incorporating more plant-based milk into their diet from doing so. Research indicates that consumers are more price sensitive to plant-based milks, and their higher cost may discourage their overall purchase and consumption (Nes et al, 2024). The VAT gap could also undermine governments' climate change goals by discouraging a transition to more environmentally friendly milk consumption.

The study of consumer response to VAT amendments for plant-based foods is limited. However, an observation of the literature related to general consumer response to VAT changes may prove illustrative. Springmann et al. (2025) estimates that maximizing the VAT on meat and dairy would decrease their overall demand by 9%, and eliminating the VAT on fruits and vegetables would increase their demand by 8% in European countries. A similar analysis by Oebel et al (2024) shows that reducing the VAT on organic vegetarian food to 0% and increasing the VAT on meat and fish to 19% would lead to a 22% increase in demand for the former in Germany. Farkas et al. (2025) investigate the impact of a 50% reduction in the VAT on relatively 'healthy' foods like maize, rice, wheat and soybeans and the simultaneous 100% increase in the VAT on relatively 'unhealthy' options such as butter, cheese, beef, pork and sweeteners in the European Union (EU). Their results show a

4% fall in consumption in the latter. The impact of lowering the VAT on plant-based milks without any associated changes to other categories of food and beverage has not yet been quantified.

Caution must be applied in implementing policy measures through VAT changes. Research indicates that price responses to VAT adjustments may be asymmetric, with increases in VAT more fully passed through to prices than decreases (Benzarti et al, 2020, Kosonen 2015). This suggests that savings from VAT reductions are not entirely passed through to consumers, with a decrease in prices channelling profits towards firms, a phenomenon that is more pronounced within low profit margin sectors (Benzarti et al, 2020). Other studies demonstrate a full pass-through of VAT reductions to food pricing (Forteza et al, 2024), particularly when consumers are highly aware of such policy changes (Bernardino et al, 2025).

As one of the key limitations of studies assessing the potential impact of food taxes for sustainability is their reliance on often overly restrictive supply-side assumptions (e.g., passive pricing and perfect price transmission along agri-food chains) (Bonnet and Réquillart 2013a; 2013b; Bonnet, Bouamra-Mechemache, and Corre 2018), this study investigates the impact of a VAT reform on dairy and plant-based milk products accounting for the strategic reactions of milk producers. This enables us to analyse price transmission dynamics along modern agri-food chain and their implications for the expected policy effectiveness.

To do so, we use CIRCANA retail scanner data of food purchases in all supermarkets and hypermarkets in Italy over a five-year period (March 2021-February 2026) to estimate demand for ultra-high temperature (UHT) milk and related plant-based substitutes through the random coefficient logit demand model approach (Berry et al., 1995; Nevo, 2000). Under the assumptions of a pure-strategy Nash-Bertrand equilibrium for producers and a constant mark-up rule for retailers, the estimated demand parameters are used to recover the mark-up and marginal costs for each product. Combined with the estimated price elasticities, these parameters are then employed to carry out a counterfactual simulation in which we assume the VAT rate on plant-based milk to be lowered to encourage purchases in this category.

The rest of the paper is organized as follows: section 2 describes the theoretical model, while data and the estimation approach are illustrated in section 3. The key results of this analysis are discussed in section 4, while section 5 concludes.

2. Model and methods

2.1 Demand model

In the present study, the demand for dairy UHT milk products and plant-based substitutes is modelled according to the random coefficient logit demand model (Berry, Levinsohn, and Pakes, 1995) (herein BLP). In details, the indirect utility that each consumer *i* gets from good *j* in market *m* is a function of its price (p_{jm}), the observed and unobserved (by the econometrician) product characteristics (X_{jm}, ξ_{jm}), and the unknown parameters (α_i, β), as follows:

$$U_{ijm} = \alpha_i p_{jm} + \beta X_{jm} + \xi_{jm} + \varepsilon_{ijm}, \tag{1}$$

where ε_{ijm} is a mean zero stochastic term that is assumed to be independently and identically distributed (i.i.d) with an extreme value type I distribution (Berry, Levinsohn, and Pakes, 1995; Nevo, 2000).

The random parameter α_i enables to account for heterogeneity in consumers' preferences for price and is defined as follows:

$$\alpha_i = \alpha + \sigma v_i,\ v_i \sim P_v(v) \tag{2}$$

where α represents the mean preference parameter for price, v_i is a vector of unobserved demographic characteristics that follows a known parametric distribution $P_v(v)$, and σ is the associated parameter measuring the unobserved heterogeneity of consumers in relation to the price parameter. For simplicity, in our analysis we assume $P_v(v)$ has a standard normal distribution.

The model assumes that each consumer purchases only one unit of the good yielding the highest utility, and that ties do not occur. An outside option has also to be defined to account for the possibility that consumers choose not to buy any of the products available in the choice set (Nevo 2000). Under these assumptions, the probability that consumer *i* chooses product *j* in market *m,* $Prob_{ijm}$, can be derived as follows (Nevo 2000) :

$$Prob_{ijm} = \frac{\exp\left(\delta_{jm} + u_{ijm}(v)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}(v)\right)} \tag{3}$$

while the market share for each product *j,* s_{jm}, can be derived by aggregating (3) over all consumers:

$$s_{jm} = \int Prob_{ijm}\, dP_v(v) = \int \frac{\exp\left(\delta_{jm} + u_{ijm}(v)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}(v)\right)}\, dP_v(v). \tag{4}$$

Since the integral in (4) has no closed form solution, it can be approximated using a simulation-based estimator that replaces the population density with the empirical distribution constructed from *ns* random draws (Berry, Levinsohn, and Pakes, 1995):

$$s_{jm} = \frac{1}{ns}\sum_{i=1}^{n} Prob_{ijm} = \frac{1}{ns}\sum_{i=1}^{n} \frac{\exp\left(\delta_{jm} + u_{ijm}(v)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}(v)\right)} \quad (5)$$

The estimated parameters from equation (5) can then be employed to estimate own- and cross-price elasticities of demand for each product as follows:

$$\eta_{jkm} = \frac{\partial s_{jm}}{\partial p_{km}} \frac{p_{km}}{s_{jm}} = \begin{cases} \frac{p_{jm}}{s_{jm}} \int \alpha_i\, s_{ijm}\left(1 - s_{ijm}\right) \mathrm{dP}_v(v) & \text{if } j = k, \\ -\frac{p_{km}}{s_{jm}} \int \alpha_i\, s_{ijm}\, s_{ikm}\, \mathrm{dP}_v(v) & \text{if } j \neq k\,. \end{cases} \quad (6)$$

2.2 Supply model and simulation approach

Following the framework by Berry, Levinsohn, and Pakes (1995), the profit function of a multiproduct firm f, supplying a subset J_f of the J products in the market, given a VAT rate, τ_j, can be expressed as follows:

$$\Pi_f = \Sigma_{j \epsilon Jf}\left(\frac{p_j}{1+\tau_j} - mc_j\right) M s_j(p, X, \xi; \theta) - C_f\ , \quad (7)$$

where p_j and mc_j are the price and marginal cost of product j, respectively; M is the market size; s_j is the market share of product j; θ includes the estimated demand parameters; and C_f are the fixed production costs.

Under the assumption of a pure-strategy Nash-Bertrand equilibrium, the resulting profit-maximizing pricing conditions are given by:

$$\frac{\partial \Pi_f}{\partial p_j} = \frac{1}{1+\tau_j} s_j(\bullet) + \Sigma_{r \epsilon Jf}\left(\frac{p_r}{1+\tau_r} - mc_r\right) \frac{\partial s_r(\bullet)}{\partial p_j} = 0, \quad \text{for all } j \epsilon J_f\ , \quad (8)$$

which can be re-written in matrix form as follows:

$$D_\tau^{-1} \mathrm{s}(\bullet) - \Omega(p)\, \Lambda\left(D_\tau^{-1} p - mc\right) = 0\ , \quad (9)$$

where $D_\tau^{-1} = diag\left(\frac{1}{1+\tau_1}, \frac{1}{1+\tau_2}, \dots, \frac{1}{1+\tau_j}\right)$, $\Omega(p)$ is the matrix of partial derivatives of the market shares with respect to prices, whereas Λ is the market structure matrix whose elements are defined as follows (Berry, Levinsohn and Pakes, 1995):

$$\Omega_{rj}(p) = -\frac{\partial s_r(\bullet)}{\partial p_j}, \quad \text{for each } j, r\ \epsilon \mathrm{J_f} \quad (10)$$

$$\Lambda_{jr} = \begin{cases} 1 \text{ if } r, j \in J_f \\ 0 \ \text{ otherwise} \end{cases} \quad (11)$$

Solving the system of equations reported in (9) allows to recover the price-cost margins and, the marginal cost associated with each product j, as follows:

$$(p\text{-}mc) = (\Omega(p)\, \Lambda)^{-1} D_\tau^{-1} \mathrm{s}(\bullet) \quad (12)$$

$$mc = D_{\tau}^{-1} p - (\Omega(p)\,\Lambda)^{-1}\, D_{\tau}^{-1} s(\bullet) \tag{13}$$

Then, the new equilibrium prices (p_j^*) in presence of a VAT reform, τ', can be derived by solving the following equation:

$$\min_{\{p_j^*\}_{j=1,\dots,J}} \quad \| D_{\tau'}^{-1} p_j^* - \Lambda(p_j^*, \tau') - mc_j' \| \tag{14}$$

where ||.|| is the Euclidean norm in $\mathbb{R}_J$ while Λ corresponds to the manufacturers' margin.

3. Data and estimation approach

In our empirical application we use CIRCANA retail scanner data of dairy milk and plant-based substitutes purchases in all supermarkets and hypermarkets in Italy over a five-year period (March 2021-February 2026). Products are defined based on vendor name (national brand (NB1 to NB7) and private labels (PLs)), segment (i.e., dairy whole milk, dairy skimmed milk, dairy lactose free milk, plant-based milk) while a market is defined as a region-time period combination, with a time period consisting of 4 consecutive weeks. Therefore, the market share of each product is computed as the ratio of its total sales value over the total sales value of dairy milk and plant-based substitutes in the relevant market. Average prices are then derived as the ratio of the total sales value divided by the total volume sold (euro/litre).

In line with the previous literature investigating demand for differentiated products through the BLP approach (e.g., Nevo 2001; Bonnet and Réquillart 2013a; 2013b, Tiboldo et al., 2024), our sample consists of 19 products having a market share strictly above 0.1%. Overall, the "inside" option accounts for 71% of total sales in this category. The summary statistics for the selected products are reported in Table 1.

Table 1. Summary statistics of the selected sample (n=24,341).

Product	Vendor	Segment	Share (%)	Price (€/L)
1	NB4	Dairy whole milk	0.16%	1.23
2	PL	Dairy whole milk	2.98%	0.91
3	NB2	Dairy skimmed milk	2.16%	0.85
4	NB3	Dairy skimmed milk	7.85%	0.89
5	NB5	Dairy skimmed milk	0.52%	1.19
6	NB4	Dairy skimmed milk	0.60%	0.95
7	PL	Dairy skimmed milk	9.91%	0.82
8	NB6	Dairy skimmed milk	1.03%	0.98
9	NB2	Dairy lactose-free milk	0.57%	1.14
10	NB3	Dairy lactose-free milk	2.65%	1.27
11	NB5	Dairy lactose-free milk	24.56%	1.36
12	PL	Dairy lactose-free milk	2.65%	1.10
13	NB1	Plant-based milk	3.74%	2.41
14	PL	Plant-based milk	1.66%	1.56
15	NB1	Plant-based milk	2.87%	2.39
16	PL	Plant-based milk	1.03%	1.48
17	NB1	Plant-based milk	3.87%	2.20
18	PL	Plant-based milk	1.08%	1.41
19	NB7	Plant-based milk	1.56%	1.96

Source: Authors' calculation using CIRCANA data (2021-2026).

Notes: The average market share for each product is computed as the ratio of the total value of purchases for that product over the total value of long-life milk purchases in Italian supermarkets and hypermarkets over the period 2021-2026. Average prices are derived as the ratio of the total sales value divided by the total volume sold for each product.

The demand function defined in section 2.1 can be estimated using a Generalized Method of Moments (GMM) estimator, as described in Berry, Levinsohn, and Pakes (1995) and Nevo (2000). However, we adopt an instrumental variable approach to address the potential endogeneity issue of prices. In details, we use monthly-level observations of supply shifters as IVs, the average unit size, fuel price indices (Ministry of Environment and Energy Security), the price of raw milk (CLAL) and soybean (ISMEA)[1]. We also add optimal instruments to enable the estimation of random coefficients and to increase the estimation efficiency (Vincent 2015).

The following variables are included in the model estimation to account for the observables product characteristics (X_j): 1) Vendor dummy variables (i.e., NB1 to NB7 and PLs); segment dummy variables (i.e., dairy whole milk, dairy skimmed milk, dairy lactose free milk, plant-based milk). Seasonal, regional and year fixed effects are also added to control for potential systematic differences in demand across time periods and geographic areas.

[1] Monthly level fuel prices are provided by the Ministry of Environmental and Energy Security (https://dgsaie.mise.gov.it/prezzi-mensili-carburanti), while monthly-level data on milk and soybean prices are provided by CLAL (https://www.clal.it/?section=latte_lombardia) and ISMEA (https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/12378).

4. Results

4.1 Demand and supply estimation results

Table 2 reports the estimated demand parameters for the random coefficient demand model described in section 2. The price coefficient has a negative and statistically significant impact on utility (2.144***) and the deviation from the mean (1.029***) is also statistically significant, thus indicating that the taste parameter for price meaningfully differs across consumers. Our results also show consumers' preference towards lactose-free (1.063***) and skimmed dairy milk (0.540***) rather than whole dairy milk alternatives or plant-based products (0.181***).

Table 2. Random coefficient demand model estimation results (n=24,341).

	Coeff.	St. Err.
Price	-2.144***	0.165
Price st.dev. (σ)[1]	1.029***	0.165
Skimmed milk	0.540***	0.043
Lactose-free milk	1.063***	0.041
Plant-based milk	0.181**	0.086
NB1	1.499***	0.180
NB2	-1.526***	0.035
NB3	0.033	0.040
NB4	-2.086***	0.047
NB5	0.163***	0.061
NB6	-1.366***	0.052
NB7	0.631***	0.097
Constant	-0.260	0.207

Source: Authors' calculation using CIRCANA data (2021-2026).

[1]The price standard deviation corresponds to the parameter σ in equation 2 and shows how the taste parameter for price varies with the unobserved household's heterogeneity.

Notes: *, **, and *** represent 10, 5 and 1 percent levels of statistical significance, respectively.

Regional, seasonal and year fixed effects coefficients omitted for brevity. Dairy whole milk and PLs are the segment and vendor reference categories respectively.

Focusing on the supply side, Table 3 reports the average, minimum and maximum value of the estimated own-price elasticities, price, price-cost margin, and marginal cost for the whole market, by segment and by vendors. The full matrix of average own-price and cross price elasticities is reported in the Appendix (Table A1). The average own-price elasticity ranges between -1.62 and -2.58 and is higher in absolute terms for plant-based alternatives (-2.44) than for dairy milk products (-2.01). On the other hand, the average own price elasticity values for NBs products (-2.17) and PLs alternatives (-2.19) are comparable in magnitude. Plant-based products generate higher price-cost margin in absolute terms (0.87 euros/litre) than dairy milk products (0.57 euros/litre), while the opposite is true when margins are expressed in percentage terms (45.8% and 54.6%, respectively). A similar pattern emerges when comparing NBs and PLs: on average, NBs ensures higher price-cost margin (0.70 euros/litre) in absolute terms than PLs (0.65 euros/litre), but lower percentage margins (49.3% versus 55.8%).

Table 3. Statistics (mean, min and max) of the own-price elasticity (OPE), market prices, absolute and percentage price-cost margin (PCM and %PCM) and marginal cost (MC) per litre. For all market, by segment and vendor.

Segment/vendor	OPE	Price (€/L)	PCM (€/L)	%PCM	MC (€/L)
All	-2.17	1.37	0.68	51.37	0.69
Minimum	-1.62	0.82	0.47	38.83	0.25
Maximum	-2.58	2.41	1.13	69.46	1.29
Dairy UHT milk	-2.01	1.06	0.57	54.59	0.49
Plant-based milk	-2.44	1.92	0.87	45.83	1.04
NBs	-2.17	1.45	0.70	49.32	0.75
PLs	-2.19	1.22	0.65	55.79	0.56

Source: Authors' calculation using the estimated parameters and CIRCANA data (2021-2026).

4.2. Counterfactual simulation results

In our counterfactual simulation scenario, we assume the VAT rate on plant-based milk products to be lowered from 22% to 10%, so as to align with the VAT rate applied to dairy milk, given the ongoing debate on this issue. The results of this simulation are reported in Table 4.

Our results show that prices of all plant-based products would fall substantially, with a percentage fall going from 11.6% to 15.7%. On the other hand, prices of dairy milk products would fall too, but to a lower extent (from -0.2% to -1.9%). Consequently, market shares of plant-based alternatives would increase dramatically (from 21.1% to 31.6%), while those of dairy milk products would fall (from -3.3% to -7.3%).

However, mixed results are found in terms of producers' strategic reaction to the fall in the VAR rate. Even though evidence of near-full price transmission is found for two products (i.e., product 13 and 14), with a transmission rate of 1.04 and 1.06 respectively, for most products (5 out of 7) the cost savings deriving from the reduction in the VAT rate are under-shifted to consumer prices. In detail, the product-level pass-through rate (PTR)[2] values for these products range between 83% and 93%, indicating that the VAT reduction is only partially transmitted to consumer prices. This is especially true for PLs, which show relatively lower PTR values (from 0.79 to 0.83) than NBs (from 0.88 to 1.06). It is also worth noting the strategic behaviour of vendor NB1 who over-shifts the VAT

[2] The product-level pass-through rate (PTR) compares the extent to which the VAT rate reduction is transmitted to consumer prices relative to the benchmark of full transmission.

reduction for two products (namely product 13 and 15), while under-shifting it for the other product supplied in this segment (i.e., product 17)

Table 4. Impact of the VAT reform on prices and market shares-absolute value and percentage changes (%) by product.

Product	Vendor	Segment	Price_sim (€/L)	ΔPrice (€/L)	Δ%Price	Δ%share	PTR
1	NB4	Dairy whole milk	1.23	0.00	-0.2%	-7.3%	-
2	PL	Dairy whole milk	0.91	0.00	-0.3%	-6.7%	-
3	NB2	Dairy skimmed milk	0.84	-0.01	-0.6%	-6.1%	-
4	NB3	Dairy skimmed milk	0.88	-0.01	-1.1%	-5.3%	-
5	NB5	Dairy skimmed milk	1.17	-0.02	-1.9%	-3.3%	-
6	NB4	Dairy skimmed milk	0.95	0.00	-0.4%	-6.6%	-
7	PL	Dairy skimmed milk	0.82	0.00	-0.3%	-6.6%	-
8	NB6	Dairy skimmed milk	0.97	0.00	-0.4%	-6.6%	-
9	NB2	Dairy lactose-free milk	1.14	0.00	-0.3%	-6.8%	-
10	NB3	Dairy lactose-free milk	1.26	-0.01	-0.6%	-6.2%	-
11	NB5	Dairy lactose-free milk	1.33	-0.02	-1.7%	-3.6%	-
12	PL	Dairy lactose-free milk	1.10	0.00	-0.2%	-7.1%	-
13	NB1	Plant-based milk	2.04	-0.38	-15.7%	31.6%	1.06
14	PL	Plant-based milk	1.37	-0.19	-12.2%	23.7%	0.83
15	NB1	Plant-based milk	2.03	-0.37	-15.3%	30.8%	1.04
16	PL	Plant-based milk	1.31	-0.18	-11.9%	22.4%	0.81
17	NB1	Plant-based milk	1.91	-0.28	-13.0%	26.3%	0.88
18	PL	Plant-based milk	1.25	-0.16	-11.6%	21.1%	0.79
19	NB7	Plant-based milk	1.69	-0.27	-13.7%	28.7%	0.93

Source: Authors' calculation using the estimated parameters and CIRCANA data (2021-2026).

5. Conclusions

As one of the key limitations of studies assessing the potential impact of food taxes for sustainability is their reliance on often overly restrictive supply-side assumptions (e.g., passive pricing and perfect price transmission along agri-food chains) (Bonnet and Réquillart 2013a; 2013b; Bonnet, Bouamra-Mechemache, and Corre 2018), this study investigates the impact of a VAT reform on dairy and plant-based milk products accounting for the strategic reactions of milk producers. This enables us to consider producer strategic behaviour and its implication on the expected policy outcomes.

We believe this represents an interesting case study as the Italian "VAT gap" between dairy-milk products and plant-based alternatives is one of the largest across the European Union, and so, it may dramatically discourage a transition towards more environmentally friendly milk consumption.

The results from our counterfactual simulation show that prices of all plant-based products would fall substantially after the aforementioned VAT reform, with a percentage fall going from 11.6% to 15.7%. On the other hand, prices of dairy milk products would fall to a lower extent (from

-0.2% to -1.9%). Consequently, market shares of plant-based alternatives would increase dramatically (from 21.1% to 31.6%), while those of dairy milk products would fall (from -3.3% to -7.3%).

However, mixed results are found in terms of producers' strategic reaction to the fall in the VAT rate for plant-based milk products, with evidence of near-full price transmission in some cases, but more predominantly of only partial price transmission to consumer prices. Interestingly, this pattern can also be observed referring to the same vendor (e.g., NB1), who combines these two pass-through strategies across products, potentially reflecting a "portfolio strategy".

In line with previous literature on food taxation (e.g., Bonnet and Réquillart 2013a; 2013b, Tiboldo et al., 2024) the results of the present analysis confirm that ignoring strategic pricing behaviour along the agri-food supply chain may lead to a misestimation of the potential impact of fiscal policies aimed at encouraging a transition towards healthier and more sustainable food consumption patterns.

Reference

Benzarti, Youssef, Dorian Carloni, Jarkko Harju, and Tuomas Kosonen. 2020. "What Goes Up May Not Come Down: Asymmetric Incidence of Value-Added Taxes." *Journal of Political Economy* 128 (12): 4438–74. https://doi.org/10.1086/710558.

Bernardino, T., Gabriel, R. D., Quelhas, J., & Silva-Pereira, M. (2025). The full, persistent, and symmetric pass-through of a temporary vat cut. Journal of Public Economics, 248, 105416.

Berry, Steven, James Levinsohn, and Ariel Pakes. 1995. "Automobile Prices in Market Equilibrium." *Econometrica (1986-1998); Evanston* 63 (4): 841–90.

Bonnet, Céline, Zohra Bouamra-Mechemache, and Tifenn Corre. 2018. "An Environmental Tax Towards More Sustainable Food: Empirical Evidence of the Consumption of Animal Products in France." *Ecological Economics* 147 (May): 48–61. https://doi.org/10.1016/j.ecolecon.2017.12.032.

Bonnet, Céline, and Vincent Réquillart. 2013a. "Impact of Cost Shocks on Consumer Prices in Vertically-Related Markets: The Case of The French Soft Drink Market." *American Journal of Agricultural Economics* 95 (5): 1088–108. https://doi.org/10.1093/ajae/aat055.

Bonnet, Céline, and Vincent Réquillart. 2013b. "Tax Incidence with Strategic Firms in the Soft Drink Market." *Journal of Public Economics* 106 (C): 77–88.

Decreto del Presidente della Repubblica, 26 ottobre 1972, n.633) (D.P.R.N. 633/1972). "Istituzione e disciplina dell'imposta sul valore aggiunto". Available at. https://www.normattiva.it/uri-res/N2Ls?urn:nir:presidente.repubblica:decreto:1972-10-26;633.

Farkas, B., Pérez-Domínguez, I., Pieralli, S., & Elleby, C. (2025). How effective are VAT reforms in improving healthy dietary choices by EU consumers?. Economia Agraria y Recursos Naturales, 25(1), 55-76.

Forteza, N., Prades, E., & Roca, M. (2024). Analysing the VAT cut pass-through in Spain using web-scraped supermarket data and machine learning. Documentos de Trabajo/Banco de España, 2417.

Good Food Institute Europe. (2025). Italy plant-based food retail market insights: 2022–2024. https://gfieurope.org/wp-content/uploads/2025/06/Italy-plant-based-food-retail-market-insights-2022-2024.pdf

Kosonen, T. (2015). More and cheaper haircuts after VAT cut? On the efficiency and incidence of service sector consumption taxes. Journal of Public Economics, 131, 87-100.

Nes, K., Antonioli, F. and Ciaian, P. (2024). Demand system analysis of consumer purchase of organic and plant-based alternatives to selected food products, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/090653.

Nevo, Aviv. 2000. "A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand." *Journal of Economics & Management Strategy* 9 (4): 513–48. https://doi.org/10.1111/j.1430-9134.2000.00513.x.

Nevo, Aviv. 2001. "Measuring Market Power in the Ready-to-Eat Cereal Industry." *Econometrica* 69 (2): 307–42.

Oebel, B., Stein, L., Michalke, A. et al. Towards true prices in food retailing: the value added tax as an instrument transforming agri-food systems. Sustain Sci 20, 1705–1722 (2025). https://doi.org/10.1007/s11625-024-01477-7

ProVeg International. (2024). Evolving appetites: An in-depth look at attitudes towards plant-based eating in Italy. Smart Protein Project. https://smartproteinproject.eu/wp-content/uploads/IT_ProVeg_Smart-Protein-Report_2024.pdf

ProVeg International. (2019). Plant milk report 2019. https://proveg.com/wp-content/uploads/2019/10/PV_Plant_Milk_Report_281019-1.pdf

Springmann, M., Dinivitzer, E., Freund, F., Jensen, J. D., & Bouyssou, C. G. (2025). A reform of value-added taxes on foods can have health, environmental and economic benefits in Europe. Nature Food, 6(2), 161-169.

Tiboldo G., Castellari E., and Moro D. "The distributional implications of health taxes: A case study on the Italian sugar tax", *Food Policy*, Volume 126, 2024, 102671, ISSN 0306-9192, https://doi.org/10.1016/j.foodpol.2024.102671.

Vincent, David W. 2015. "The Berry-Levinsohn-Pakes Estimator of the Random-Coefficients Logit Demand Model." *Stata Journal* 15 (3): 854–80.

Appendix 1

Table A1. Average own-price and cross price elasticity values by product.

Product	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	-2.32	0.06	0.04	0.14	0.01	0.01	0.17	0.02	0.01	0.06	0.62	0.06	0.11	0.05	0.08	0.03	0.11	0.03	0.05
2	0.00	-1.89	0.04	0.16	0.01	0.01	0.19	0.02	0.01	0.07	0.64	0.06	0.10	0.05	0.07	0.03	0.11	0.03	0.04
3	0.00	0.06	-1.81	0.16	0.01	0.01	0.19	0.02	0.01	0.07	0.65	0.06	0.09	0.05	0.07	0.03	0.10	0.03	0.04
4	0.00	0.06	0.04	-1.75	0.01	0.01	0.19	0.02	0.01	0.07	0.64	0.06	0.10	0.05	0.07	0.03	0.10	0.03	0.04
5	0.00	0.06	0.04	0.14	-2.28	0.01	0.17	0.02	0.01	0.06	0.63	0.06	0.11	0.05	0.08	0.03	0.11	0.03	0.05
6	0.00	0.06	0.04	0.16	0.01	-1.99	0.19	0.02	0.01	0.07	0.64	0.06	0.10	0.05	0.08	0.03	0.11	0.03	0.04
7	0.00	0.06	0.04	0.16	0.01	0.01	-1.62	0.02	0.01	0.07	0.65	0.06	0.09	0.05	0.07	0.03	0.10	0.03	0.04
8	0.00	0.06	0.04	0.16	0.01	0.01	0.18	-2.01	0.01	0.07	0.64	0.06	0.10	0.05	0.08	0.03	0.11	0.03	0.04
9	0.00	0.06	0.04	0.15	0.01	0.01	0.17	0.02	-2.22	0.07	0.63	0.06	0.10	0.05	0.08	0.03	0.11	0.03	0.05
10	0.00	0.05	0.04	0.14	0.01	0.01	0.16	0.02	0.01	-2.31	0.62	0.06	0.11	0.05	0.08	0.03	0.12	0.03	0.05
11	0.00	0.05	0.04	0.14	0.01	0.01	0.16	0.02	0.01	0.06	-1.83	0.06	0.11	0.05	0.08	0.03	0.12	0.03	0.05
12	0.00	0.06	0.04	0.15	0.01	0.01	0.18	0.02	0.01	0.07	0.63	-2.13	0.10	0.05	0.08	0.03	0.11	0.03	0.05
13	0.00	0.03	0.02	0.07	0.01	0.01	0.08	0.01	0.01	0.04	0.41	0.03	-2.29	0.03	0.06	0.02	0.09	0.02	0.04
14	0.00	0.05	0.03	0.12	0.01	0.01	0.14	0.02	0.01	0.06	0.58	0.05	0.11	-2.52	0.09	0.03	0.12	0.03	0.05
15	0.00	0.03	0.02	0.07	0.01	0.01	0.09	0.01	0.01	0.04	0.41	0.03	0.08	0.03	-2.33	0.02	0.09	0.02	0.04
16	0.00	0.05	0.03	0.13	0.01	0.01	0.15	0.02	0.01	0.06	0.59	0.05	0.11	0.04	0.09	-2.50	0.12	0.03	0.05
17	0.00	0.03	0.02	0.09	0.01	0.01	0.10	0.01	0.01	0.05	0.46	0.04	0.10	0.04	0.08	0.02	-2.43	0.02	0.04
18	0.00	0.05	0.03	0.13	0.01	0.01	0.15	0.02	0.01	0.06	0.60	0.05	0.11	0.04	0.09	0.03	0.12	-2.45	0.05
19	0.00	0.04	0.03	0.10	0.01	0.01	0.12	0.01	0.01	0.05	0.51	0.04	0.11	0.04	0.08	0.02	0.12	0.02	-2.58

Source: Authors' calculation using estimated parameters and CIRCANA data (2021-2026).

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