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ORIGINAL ARTICLE

Concentration, market imperfections, and interbranch organization in the Italian processed tomato supply chain

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Abstract

The increase in market concentration and market power in the food supply chain is an issue of concern globally. This study focuses on an analysis of market imperfections in the Italian processed tomato food supply chain by considering changes in its supply chain governance from 2006-2018. The identification of the degree of non-competitive behavior is based on the derived mark-down and mark-up models using the latest developments in stochastic frontier methodology. The estimated models reveal some degree of non-competitive behavior in the input as well as in the output processing market. However, in consideration of the results on the supply chain governance during the study period, we argue that the establishment of an Interbranch Organization (IBO) could create fairly stable long-term food supply chain relationships benefitting all IBO members and in particular farmers despite the significant change in concentration levels in the Italian tomato processing sector after 2015.

KEYWORDS

concentration rate, food chain, interbranch organizations, Italy, market imperfections, stochastic frontier analysis, tomatoes

JEL CLASSIFICATION D43, D71, L11, L13, Q13

INTRODUCTION 1

Farm input markets, agricultural commodity trading, processing segments, and the retail network of food supply chains have witnessed an increasing concentration across the globe (Clapp, 2021). The emergence of powerful food retailers, along with continued increases in concentration among food manufacturers, raises issues of bilateral oligopolies and countervailing power in wholesale markets (Sexton & Xia, 2018). Although increase in concentration does not necessarily lead to an exercising of market power (Crespi & MacDonald, 2022; Deconinck, 2021), the concern is that upstream market power in food value chain can create higher costs for downstream firms and downstream market power can create lower prices received for upstream firms. Furthermore, the increasing concentration and consolidation among food manufacturers and retailers reduces the potential trading partners for many farmers to only one or a few (Fałkowski et al., 2017, ch1), which can potentially reduce the bargaining power of the producers.

The creation of Producers' Organizations (POs) is one of the possible ways to increase the bargaining power of scattered primary agricultural producers, as POs make

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ČECHURA ET AL.

bulk purchases of agricultural commodities, give technical assistance and advice to their members, and sell collectively to processing industries under European Union (EU) Regulation 1308/2013 (Samoggia et al., 2022). This Regulation, which is also known as the "Common Market Organisation (CMO) Regulation", addresses the lack of bargaining power for atomized primary agricultural producers and also tries to deal with agricultural production crises. When farmers and processors or traders in the supply chain join together, they can form Interbranch Organizations (IBOs). IBOs are organizations for governing the supply chain without being involved in production, processing or trade themselves. They promote dialogue, market transparency and a reference price streamlining process in their food industry.

The above-mentioned discussion makes the measuring of the level of this concentration an important issue. Therefore, by focusing on tomato processing in Italy, we have decided to test these concentration changes in this food supply chain.¹ Italy was the third largest producer of processed tomatoes worldwide in 2020 (with 5166 million tons and +7.6% compared to 2019) after the USA (in particular California, with 10,258 million tons), and China (5800 million tons) (Tomato News, 2021b). In Europe, Italy (55.4%), Spain (25%), and Portugal (12%) are the European countries with the highest production volumes of processed tomatoes (European Commission, 2022). Italy is the second exporting country at the global level (23.6%) after China (26.3%). As such, it is the first exporting country of finished processed tomato products in the EU, followed by Spain (12.5%) and Portugal (8.2%) (Tomato News, 2021a).

In this article, we focus on the analysis of market imperfections in the Italian processed tomato supply chain from 2006 to 2018. Our aim is to identify the degree of market imperfections in the input and output tomato processing market, conduct a concentration analysis of the main companies of tomato processors and/or processing associations, and evaluate the managerial governance of the tomato supply chain regarding the sustainability, integrity and resilience from a static as well as dynamic perspective.

By focusing on the timeline of changes during 2006–2018 in the Italian tomato supply chain, we test the effects of higher coordination and higher consolidation on market imperfection. The shaping of an IBO in North Italy, which was started in 2007 and was officially recognized in 2011 at the regional level and in 2012 at the European level, is a sign of higher coordination and increased bargaining power. Furthermore, increase in the Concentration Rate (CR) of the tomato processing industry after 2014 is also a sign of higher consolidation. In light of these two factors, this study extends the research on the analysis of market imperfections. In particular, in order to fill the research gap identified by exploring the effects of the IBOs, this article addresses the following research questions: (1) what degree of non-competitive behavior of the food processors with respect to farmers and/or retailers could be observed? (2) can we observe the links between market failures and chain governance? and (3) is the supply chain becoming increasingly competitive or can an idiosyncratic development be observed?

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Our identification of the degree of non-competitive behavior is based on the derived mark-down and markup models using the latest developments in stochastic frontier methodology. Using a stochastic frontier analysis (SFA) to detect the degree of market power was first applied by Kumbhakar et al. (2012) for mark-up models. Another novelty of our study is the application of this approach in the analysis of a tomato supply chain through the decomposition of the one-sided error term in the markup and mark-down models within both the transient and persistent components along with the relation of relative mark-up and mark-down to the market power. In particular, we assume that market power comes from a company's strategy and thus only the time-invariant (persistent) component of the mark-up and mark-down models can be associated with the bargaining power. We then provide the direct relationship between the relative mark-up/relative mark-down and the degree of market power.

In Sections 2 and 3, we will analyze the processed tomato sector in Italy, in addition to IBOs and the level of concentration. A literature review on market concentration and coordination is presented in Section 4, while the data and methodology are described in section 5 and section 6 presents the main results. We provide a discussion and draw conclusions in the last two sections.

2 | ITALY'S PROCESSED TOMATO SECTOR AND INTERBRANCH ORGANIZATION (IBO)

Production of tomatoes for processing in Italy, as well as in Spain and Portugal, is locally concentrated. In Italy, the tomato processing sector is divided between a Northern production area (mainly the Emilia-Romagna region) with approximately 35% of total national production, and a Southern production area (mainly Campania and Apulia), which comprises approximately 30% of total national production (see Figure 1). In Italy in 2020, a total of 65,634 ha (+2% compared to 2019) were dedicated to the production of tomatoes for processing. About 2.74 million tons (53.1%) of processed tomatoes were produced in the Northern production area, and 2.42 million tons (46.9%) in the

¹This selection has been done under the framework of the EU Horizon 2020, VALUMICS project with grant agreement No. 727243.

AGRICULTURAL ECONOMICS



FIGURE 1 Map of major tomato producing regions of Italy (Emilia-Romagna in the north and Apulia in the south). Source: Own elaborations, made with ggplot2 (Wickham, 2016), shapefile from GADM², and tomato production data acquired from the Italian Statistics Office (ISTAT³).

Centre-South production area (ANICAV, 2020). In particular, Italy is the leading exporter of canned tomatoes in the world, accounting for 76% of the global market share of the ten main exporting countries for the 2021/2022 season (Tomato News, 2021a).

In 2007, Emilia-Romagna stakeholders encouraged the creation of the "District of Industrial Tomatoes" in order to prepare for the reduction in the levels of Common Agricultural Policy (CAP) support as part of the EU's CAP reforms. The stakeholders active in this process were POs, processors, research centers and other local institutions (Donati et al., 2019; Mantino & Forcina, 2018). The territorial area of the district expanded to include other areas dedicated to the processing of tomatoes. The IBO was established and in 2011 it was officially recognized by the Emilia-Romagna Regional government, by EU authorities in 2012 and by the Italian Agriculture Ministry in 2017 (NIPTIO,⁴ 2021b). Thus, the IBO is fully active only starting from 2011. The North of Italy progress in this regard led stakeholders in the South of Italy to establish an IBO for Southern Italy Tomato Processing in 2018, which was also eventually recognized by Italian authorities (NIPTIO, 2020).

In Northern Italy around 20 tomato processing companies process 98.9% of the tomatoes produced in the area of the IBO for Northern Italy Tomato Processing (NIPTIO, 2021b). Tomato processing is concentrated

 ² Source: https://gadm.org/download_country.html.
 ³ Source: https://www.istat.it/en/.

⁴ NIPTIO refers to "OI Pomodoro da Industria Nord Italia" which can be translated as "North of Italy Processed Tomato Interbranch Organization".

in the province of Parma, with more than half of the private processing companies and half of the processing producers' cooperatives located there (Mantino & Forcina, 2018). Tomato processing is carried out by both private companies (66% of processed tomatoes) and producers' cooperatives (34% of processed tomatoes). The largest private processing companies are located in Parma and Piacenza, such as Mutti, Rodolfi, Greci Alimentari, and Emiliana Conserve. Some of these private companies still belong to the founding families (Mantino & Forcina, 2018).

On the distribution side, around half of the processed tomatoes are sold to the food industry (47%), 36% to retail distribution, and 18% to HORECA⁵ (NIPTIO, 2021a). The processing tomato supply chain of the IBO for Northern Italy Tomato Processing strives for a strong vertical and horizontal cooperation, both internally among IBO actors and with other supply chain stakeholders.

Annual processed tomatoes are produced on a contractual basis agreed upon by IBO stakeholders at the beginning of the agronomic year. Moreover, the IBO stakeholders agree on the general rules that form the basis of a framework contract, which sets the tomato production and commercial relationships within the IBO for Northern Italy Tomato Processing, between producers, processors, and self-processing cooperatives. The framework contract includes an approximate and proposed price that is then renegotiated bilaterally by the chain actors, in particular the producer organizations and processing industries.

The IBO allows for both vertical and horizontal integration in the tomato processing industry. It works as a neutral space where trade-offs between the clashing interests of producers and processors can be found. The IBO streamlines the negotiation of a reference price between producers and processors, helps the coordination of production planning in order to solve conflicting interests, and thus stabilizes the market. It also impacts the food chain both upstream (influencing policies and financing) and downstream (affecting crop planning).

The price streamlining is a key aspect of IBO. The negotiation of the reference price of raw tomato to be processed and paid to producers by processors can take up to some months. The reference price is not a set minimum price, but a reference price agreed, mainly based on the historical prices paid in the past and through the analysis of past contracts. The reference price varies according to qualitative parameters specified in the framework contract, as agreed by all IBO's companies.

The two parameters affecting the final price are the level of "BRIX", and the percentage of major and minor defects of the tomato to be processed. BRIX is a measure of the sugar content of a tomato. The higher the BRIX, the sweeter the tomato. Major defects are defects that significantly affect the quality of the tomato, such as bruises or rot. Minor defects are defects that do not significantly affect the quality of the tomato, such as small blemishes (Samoggia et al., 2022).

3 | CONCENTRATION

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Another development in the Italian tomato processing sector has been the increase in the Concentration Rate (CR) after 2012. Table 1 shows the top eight Italian firms and their share and concentration level in tomato processing in the last year of this study (2018).

As can be observed, the CR of the top 1, 4, and 8 firms (*CR1*, *CR4*, and *CR8*) in 2018 was 11.6%, 39.8%, and 56.4%, respectively, although this picture was different before 2015. Figure 2 shows the development of the CR for the top 1, 2, and 4 firms (*CR*₁, *CR*₂ and *CR*₄) for the 2006–2020 period. As can be seen, the CR dramatically changed after 2014. During this period, the annual amount of tomato processing did not vary a lot in Italy and the average annual tomato processing was 4.9 million tons with a coefficient of variation of 9.28% (Tomato News, 2021c).

According to available information, in 2015, Agricoltori Riuniti Piacentini (A.R.P) merged with Casalasco; in 2017 COPADOR was taken over by Mutti (Tomato News, 2017); and in 2018 Ferrara Foods was purchased by Italtom (Tomato News, 2018), which were some of the main merges since 2014. It must be mentioned that higher level of concentration in the food supply chain does not necessarily mean higher market power or price change (Dong et al., 2023).

4 | POS, IBOS, BARGAINING POWER AND MARKET IMPERFECTION

There have been substantial amounts of research conducted on the presence of market power and a deviation from competitiveness. A general overview on these studies can be found in Crespi and MacDonald (2022), Deconinck (2021), and Sexton and Xia (2018). By considering the current governance of the Italian tomato processing supply chain, we focus on those studies that have analyzed the role of POs on increasing the bargaining power between actors of the supply chain and their effect on market imperfection.

There is a general perception among both the public and policymakers that farmers' share of the overall food value is unfairly low (Busch & Spiller, 2016; Samoggia et al., 2021) and the collective decisions of farmers in organizations such as POs can improve both market efficiency

⁵ HORECA refers to hotel, restaurant and cafè.

AGRICULTURAL ECONOMICS

TABLE 1 The top eight Italian firms and their share and concentration level in tomato processing in 2018.

		Fresh	Firm	Cumulative tomatoes	
Rank	Firm name	tomatoes (1000 Tons)	share (%)	processed (1000 Tons)	Concentration rate (%)
1	Mutti	540	11.61	540	11.61
2	Italtom	471	10.13	1,011	21.74
3	Conzorzio Casalasco	463	9.96	1,474	31.70
4	Conserve Italia	377	8.11	1,851	39.81
5	La Doria	241	5.18	2,092	44.99
6	Rodolfi Mansueto	220	4.73	2,312	49.72
7	Princes Industrie Alimentari	186	4.00	2,498	53.72
8	Solana	125	2.69	2,623	56.41
	Rest of Italy	2,027			
	Total Italy	4,650			

Source: Conserve Italia, La Doria and Tomato News.



FIGURE 2 Concentration rate for top the 1, 2, and 4 firms (*CR1*, *CR2* and *CR4*) for the period 2006–2018.

Source of data: Tomato News, La Doria annual reports, Mutti, Conserve Italia.

and bargaining power (Sorrentino et al., 2018). The condition of atomized upstream suppliers of the supply chain and downstream concentrated or limited buyers of supply chains are discussed theoretically and through simulation by Mérel (2011) and Mérel and Sexton (2017). For instance, by considering the French Comté cheese market, Mérel (2011) argues that encouraging industry coordination may be socially desirable.

The dairy farm cooperatives are one of the major agrifood POs that have been studied. By using the regional data of U.S. dairy cooperatives for the 2000–2007 period, Cakir and Balagtas (2012) have shown that cooperatives use the federal milk market ordering regulations to exercise their market power by having 9% mark-ups on farm milk prices. When such a cooperative is not available, the possibility of market power to be exercised by privately owned dairy processors is very high. The effect of cooperatives on market power in the Italian fruit and vegetable (F&V) and dairy supply chains have been tested by Lee and Van Cayseele (2022) for the 2007–2014 period. Compared to non-cooperatives, they found higher mark-ups for F&V processor cooperatives and lower mark-ups for F&V farmer and dairy processing cooperatives.

To our knowledge, the effects of IBOs on bargaining power and market imperfection have not been empirically tested. The creation of IBOs can be justified by Sexton's (2013) Modern Agricultural Market (MAM) concept. He argues that food processing firms consider their long-term relationship with agricultural producers (such as tomato or dairy farmers). From his point of view, before exercising market power, processing firms consider their capital cost investment, inelastic demand for agricultural products and transaction costs. Sexton argues that the processing firms need a reliable supply of agricultural products with certain characteristics to fulfil their output obligations (Sexton, 2013). Therefore, he argues that the coordination between agricultural producers and processors is beneficial for both and that IBOs are an example of such coordination.

In this study, we look to the effect of the IBOs and, at the same time, the increasing concentration on market imperfection. Given the fact that market power comes from a company's strategy having a long-term nature as Sexton argues, thus only the time-invariant (persistent) one-sided component of the mark-up and mark-down model can be associated with the bargaining power.

From the empirical point of view, we have decomposed the one-sided error term in the mark-up and mark-down model within both the transient and persistent components to avoid upward biases of mark-up and mark-down components. Moreover, we use an estimation procedure that addresses three sources of potential endogeneity that ECONOMICS

are highly probable for our models: (i) unobserved heterogeneity; (ii) simultaneity of regressors with persistent and transient components; and (iii) correlation of regressors with the noise term. Finally, we provide a direct relationship between mark-up and mark-down components with a market power indicator.

5 | DATA AND METHODOLOGY

5.1 | Data

The data we use in the analysis is drawn from the Amadeus database,⁶ created and produced by Bureau van Dijk. The database contains financial information for private companies across Europe and provides detailed information about (standardized) annual accounts, financial ratios, sectoral activities and ownership information. The panel dataset that we use in our analysis contains companies whose main activities are tomato food processing according to the NACE classification and desk research of each of the company websites. It is a panel dataset that represents the period from 2006 to 2018 and contains 97 companies that process only tomatoes or mainly tomatoes.

The following variables are used in the analysis:

Mark-down model: consists of cost share = material costs/revenue as a dependent variable and material costs, capital and labor as covariates. Material costs are used in the form of the total cost of materials and energy consumption per company. Revenue is represented as the operating revenue (turnover) of the companies and materials is the total costs of materials and energy deflated by the index of producer prices in the industry (2010 = 100). This indicator is a relative rough approximation of the expenditure for raw agricultural materials. However, the fact that we are analyzing the tomato processing industry where agricultural raw materials constitute the bulk of the material costs, we assume that the approximation is acceptable. Labor is represented by the cost of employees deflated by consumer price index (2010 = 100). Capital is the book value of fixed assets deflated by the index of producer prices in the industry (2010 = 100).

Mark-up model: consists of revenue share = revenue/costs as the dependent variable and output, normalized material costs and labor as covariates, while revenue is represented by the operating revenue (turnover) of a company and costs are the sum of the labor costs, materials costs and capital costs. Labor costs are represented by the costs of employees, material costs are the total costs of materials and energy consumption per company, and capital costs are calculated as the book value of fixed assets multiplied by the interest rate according to convergence criteria.

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Outputs are represented by the operating revenue (turnover) of a company and are deflated by the sectoral index of tomato processing prices (2010 = 100). Material and labor are normalized by capital. For the case of the mark-down model, materials is the total costs of materials and energy deflated by the index of producer prices in the industry (2010 = 100); labor is represented by the costs of employees deflated by the consumer price index (2010 = 100); and capital is the book value of fixed assets deflated by the index of producer prices in the industry (2010 = 100); and capital is the book value of fixed assets deflated by the index of producer prices in the industry (2010 = 100).

We reject producers with fewer than four observations (on average) to comply with the requirements of the Generalized Method of Moments (GMM) estimator. Furthermore, we decrease the problem with the use of unbalanced panel data this way. Finally, the GMM model estimates used input variables as instruments lagged up to two periods for the equation in levels and up to three periods for the equation in differences. We then use year dummies and the size variable for the mark-down model and year dummies for the mark-up model as additional instruments. Summary statistics of the main variables are provided in Table 2. Finally, the dependent variable and the covariates are logarithmically transformed and normalized by their mean in both models.

5.2 | Theoretical models

The mark-down and mark-up models are derived using the conjectural variation approach (e.g., Bresnahan, 1982; Muth & Wohlgenant, 1999). We follow the standard behavioral assumption about profit maximization. In this case, the Optimization Problem (OP) can be approached either as input- or output-market oriented.

Input market-oriented OP-mark-down model

$$\pi_i = R\left(\boldsymbol{p}, x_i, \boldsymbol{z_i}, t\right) - w_x \cdot x_i - \boldsymbol{w'_z} \cdot \boldsymbol{z_i}$$
(1)

where π_i is the profit of *i*th processor, $R(\mathbf{p}, x_i, \mathbf{z}_i, t)$ represents the revenue function depending on the vector of product prices (\mathbf{p}), agricultural raw materials (x_i), *k*th other inputs ($z_{i,k}$) and a time trend (t) as an indicator of technical change. The symbol w_x and w_z are used for the corresponding factor prices, and the supply function of raw materials is:

$$x = g(w_x, s) \text{ or } w_x = g^{-1}(x, s)$$
 (2)

⁶ More information on the Amadeus database (since 2021 Orbis Europe) is provided at: http://www.bvdinfo.com.

TABLE 2 Summary statistics of main variables (thousands of Euros).

Variable	Mean	Standard deviation	Minimum	Maximum
Operating revenue (Turnover) (R)	33,401.5	113,028.0	135.0	1,052,047.0
Total costs of materials and energy (M)	20,507.7	65,504.6	57.8	542,232.8
Costs of employees (L)	3112.2	12,024.1	.6	121,197.7
Book value of fixed assets (C)	12,025.4	46,711.2	1.3	465,413.9

Source: Own calculation from Amadeus data.

where **s** is a vector of supply shifters and $x = \sum_{i=1}^{I} x_i$ is the total supply of raw material (summing over *I* processors), or in terms of the inverse supply function $w_x = g^{-1}(x, \mathbf{s})$. Then, the first order condition for profit maximisation is:

$$\frac{\partial R(\mathbf{p}, x_i, \mathbf{z}, t)}{\partial x_i} - w_x - \frac{\partial g^{-1}(x, \mathbf{s})}{\partial x} \frac{\partial x}{\partial x_i} x_i = 0 \quad (3)$$

and after rearrangement:

$$w_x\left(1+\frac{\Theta}{\varepsilon_x}\right) = \frac{\partial R(\mathbf{p}, x, \mathbf{z}, t)}{\partial x}, \text{ where }$$
(4)

$$\varepsilon_x = \frac{\partial x}{\partial g^{-1}(x, \mathbf{s})} \frac{g^{-1}(x, \mathbf{s})}{x} = \frac{\partial lnx}{\partial lnw_x} > 0$$

In Equation (4), ε_x denotes the price elasticity of the raw tomato supply and $\Theta = \frac{\partial x}{\partial x_i} \frac{x_i}{x}$ is a conjectural elasticity capturing the degree of oligopsonistic market power (Bresnahan, 1989). The parameter range is $0 < \Theta < 1$. $\Theta = 0$ corresponding to perfect competition, while $\Theta = 1$ characterizes a monopsonistic market.⁷ Using Equation (4) and the relative mark-down measure (σ), we derive a direct relation between conjectural elasticity and relative markdown. In particular, the mark-down measures the percent deviation of factor prices from their Marginal Revenue Product (MRP)⁸ as $\sigma = \frac{MRP_x - w_x}{MRP_x}$. Substituting the factor cost with market power (MRP_x^{MP}) and the factor cost under perfect competition ($MRP_x^{C} = w_x^{C}$) into the relative mark-down results in:

$$\sigma_{MP_{-}C} = \frac{MRP_{x}^{MP} - w_{x}^{C}}{MRP_{x}^{MP}} = \frac{\frac{1}{(1+\frac{\Theta}{\varepsilon_{x}})}\frac{\partial R}{\partial x} - \frac{\partial R}{\partial x}}{\frac{1}{(1+\frac{\Theta}{\varepsilon_{x}})}\frac{\partial R}{\partial x}} = \frac{\frac{1}{(1+\frac{\Theta}{\varepsilon_{x}})} - 1}{\frac{1}{(1+\frac{\Theta}{\varepsilon_{x}})}} = -\frac{\Theta}{\varepsilon_{x}}$$
(5)

That is, relative mark-down (σ_{MP_C}) is proportional (in absolute value) to the indicator of market power and can be directly computed when the supply elasticity (ε_x) and conjectural elasticity (Θ) are known. Or, if we know relative mark-down and supply elasticity, we may calculate conjectural elasticity. Finally, if the supply elasticity is unknown but supposed to be constant in the long run, we may use Equation (5) to investigate dynamics in conjectural elasticity in case that relative mark-down is estimated and vice versa.

Moreover, the Equation (4) implies that: $w_x = MRP_x = \frac{\partial R}{\partial x}$ under perfect competition. This relation can further be expressed expanding both sides by $\frac{x}{p}$ as:

$$w_x \frac{x}{R} \le MRP_x \frac{x}{R} = \frac{\partial R}{\partial x} \frac{x}{R} = \frac{\partial lnR}{\partial lnx} = \frac{\partial lnD^0}{\partial lnx}$$
 (6)

where the last equality comes from the duality of the revenue (*R*) and output distance (D^{0}) functions (Shephard, 1970) and the inequality occurs when conjectural elasticity (Θ) is nonzero, that is, the situation with a certain degree of market imperfections.

Output market-oriented OP-mark-up model

The optimization problem can be introduced for the output market in the analogical way. In this case, the profit function of processor (i) is given by:

$$\pi_i = p.y_i - C(\boldsymbol{w}, y_i, t) \tag{7}$$

where *p* is a price of output, y_i is the output of *i*th processor, *w* is a vector of input prices, and $C(w,y_i,t)$ is a cost function of processor (*i*) and time trend (*t*) for capturing technical change. The corresponding first-order condition for profit maximization is:

$$\frac{\partial f^{-1}(y, \boldsymbol{d})}{\partial y} \cdot \frac{\partial y}{\partial y_i} \cdot y_i + p - \frac{\partial C(\boldsymbol{w}, y_i, t)}{\partial y_i} = 0 \text{ or } (8)$$

⁷ Since prices of other inputs are assumed to be constant, their optimal level is given when the factor price is equal to the value of Marginal Revenue Product (*MRP*): $W_z = \frac{\partial R(p_{x}, z, t)}{\partial z}$. ⁸ The relative mark-down is analogously defined to the Lerner index

⁸ The relative mark-down is analogously defined to the Lerner index (Lerner, 1934) which measures the degree of oligopolistic power. The Lerner index gives the percent of the prices that are above marginal cost. The relative mark-down is correspondingly the percentage the factor price is below the value of the marginal revenue product.

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$$\left(1 + \frac{\Omega}{\varepsilon_p}\right) = \frac{\partial C\left(\boldsymbol{w}, y_i, t\right)}{\partial y_i}$$
(9)

where **d** is a vector of demand shifters, $\varepsilon_p = \frac{\partial y}{\partial f^{-1}(y,d)} \frac{p}{y} < 0$ stands for a demand elasticity of the final product and $\Omega = \frac{\partial y}{\partial y_i} \cdot \frac{y_i}{y}$ is a conjectural elasticity. This conjectural elasticity provides information about the the degree of oligopolistic market power. In particular, the elasticity is in the interval $\Omega \in [0, 1]$ where $\Omega = 0$ indicates competitive behavior and $\Omega = 1$ characterizes monopolistic power.

Analogically to input market, Equation (9) can be used to derive the relation between conjectural elasticity and the relative mark-up (φ) measured as the percent deviation of product price from the marginal cost: $\varphi = \frac{P-MC}{MC}$ (Kumbhakar et al., 2012).⁹ That is, substituting the product price with market power (p^{MP}) and marginal cost under perfect competition ($p^C = MC^C$) into the relative mark-up results in:

$$\varphi_{C_MP} = \frac{p^C - MC^{MP}}{MC^{MP}} = \frac{\frac{\partial C}{\partial y} - \frac{1}{\left(1 + \frac{\Omega}{\epsilon_p}\right)}\frac{\partial C}{\partial y}}{\frac{1}{\left(1 + \frac{\Omega}{\epsilon_p}\right)}\frac{\partial C}{\partial y}} = \frac{1 - \frac{1}{\left(1 + \frac{\Omega}{\epsilon_p}\right)}}{\frac{1}{\left(1 + \frac{\Omega}{\epsilon_p}\right)}} = \frac{\Omega}{\epsilon_p}$$
(10)

Equation (10)¹⁰ shows that the relative mark-up (φ_{C_MP}) is proportional (in absolute value) to the indicator of market power and can be directly computed when the demand elasticity and conjectural elasticity are known. On the contrary, if the relative mark-up and demand elasticity are known, we may calculate conjectural elasticity. Finally, if the demand elasticity is supposed to be constant in the long run, we may use Equation (10) to study dynamics in conjectural elasticity in case that relative mark-up is estimated and vice versa.

Moreover, it follows from Equation (9) that: $p \ge \frac{\partial C(w, y_i, t)}{\partial y_i}$ for $\Omega \in [0, 1]$, which can be expressed expanding both sides by $\frac{y}{c}$ as:

$$\frac{p.y}{C} \ge \frac{\partial C\left(\boldsymbol{w}, y_{i}, t\right)}{\partial y_{i}}, \frac{y}{C} = \frac{\partial lnC}{\partial lny} = \frac{\partial lnD^{I}}{\partial lny}$$
(11)

where the last equality comes from the duality of the cost (C) and input distance (D^I) functions (Shephard, 1970).

5.3 | Estimation strategy

The inequalities in (6) and (11) can be transformed to the equalities by adding a non-negative one-sided error terms, u for the mark-down model and ε for the mark-up model (see Kumbhakar et al., 2012 for the mark-up model):

$$\frac{w_x \cdot x}{R} = \frac{\partial ln D^o}{\partial ln x} - u, \ u \ge 0 \text{ and}$$
(12)

$$\frac{p.y}{C} = \frac{\partial lnD^{I}}{\partial lny} + \varepsilon, \ \varepsilon \geq 0$$

In Equation (12), u captures the mark-down and ε the mark-up. To estimate mark-down and mark-up for each firm we use stochastic frontier methodology from the efficiency literature (e.g., Kumbhakar & Lovell, 2000).

Then, assuming that both the output and input distance functions have translog form, the resulting mark-down (13) and mark-up (14) models, respectively, for one output is as follows¹¹:

$$\frac{w_x x}{R} = \beta_x + \beta_{xt} t + \beta_{xx} lnx + \beta'_{zx} lnz - u \text{ and}$$
(13)

$$\frac{py}{C} = \alpha_y + \alpha_{yt}t + \alpha_{yy}lny + \alpha'_{xy}ln \stackrel{\sim}{x} + \varepsilon, \text{ where } (14)$$

 $\widetilde{x_j} = x_j / x_J$ for $j = 1, \dots, J$.

The coefficients α and β in Equations (13) and (14) are actually the coefficients of the first order derivation of translog output and input distance functions, respectively, which is the reason for the notation structure of the coefficients. Kumbhakar et al. (2012) first applied the stochastic frontier approach in the estimation of the degree of market power in Equation (9). In our study, we adjust this approach in the following way: we use a system GMM estimator to address the endogeneity problem and to obtain unbiased parameters as well as error components. Then, we decompose a non-negative one-sided error term to the transient (time variant) and persistent (time-invariant) parts, that is, $u_{i,t} = \mu_{i,t} + \eta_i$ for the mark-down model and $\varepsilon_{i,t} = \zeta_{i,t} + \psi_i$ for the mark-up model. Moreover, the intercept terms will be related to heterogeneity components to respect the different firm's technologies. This conceptual distinction of the four components¹² allows getting unbiased estimates of the one-sided error terms. In particular, since the market power is a product of firm strategy that

⁹ The relation of the relative mark-up and Lerner index is: $L = \frac{P - MC}{P} = \frac{\varphi}{P}$.

 $[\]frac{1}{1+\varphi}$. ¹⁰ Note: using Lerner index in Equation (10) instead of relative mark-up results in: $L_{C_{_{_{_{}}}MP}} = \frac{\Omega}{\varepsilon_{n}+\Omega}$.

¹¹ The detail information on output and input distance functions and the derivation of models (13) and (14) are provided in the Appendix.

¹² The model specification is an analogy to the 4-component stochastic frontier model (Tsionas & Kumbhakar, 2014).

has a long-term nature, our primal interest is to get unbiased estimates of the persistent (time-invariant) part of the one-sided error term. That is, the models to be estimated are:

$$\frac{w_{x}x_{i,t}}{R_{i,t}} = \left(\beta_{0} + \beta_{x_{i}}\right) + \beta_{xt}t + \beta_{xx}lnx_{i,t} + \beta'_{zx}lnz - \mu_{i,t} - \eta_{i} + \upsilon_{i,t}$$
(15)

$$\frac{py_{i,t}}{C_{i,t}} = (\alpha_0 + \alpha_{y_i}) + \alpha_{yt}t + \alpha_{yy}lny_{i,t} + \alpha'_{xy}ln \stackrel{\sim}{x} + \varsigma_{i,t} + \psi_i + e_{i,t},$$
(16)

where subscript i = 1, ..., I, refers to the processors (*i*) and t = 1, ..., T denotes time. The distributional assumptions¹³ are as follows:

- mark-down model: $v_{i,t} \sim N(0, \sigma_v^2)$, $\mu_{i,t} \sim N^+(0, \sigma_\mu^2)$, $\eta_i \sim N^+(0, \sigma_\eta^2)$ and $\beta_{x_i} \sim N(0, \sigma_\beta^2)$
- mark-up model: $e_{i,t} \sim N(0, \sigma_e^2)$, $\varsigma_{i,t} \sim N^+(0, \sigma_\varsigma^2)$, $\psi_i \sim N^+(0, \sigma_{\psi}^2)$ and $\alpha_{y_i} \sim N(0, \sigma_{\alpha}^2)$

Moreover, the components in each model are assumed to be independent of each other and of regressors. The endogeneity problem resulting from the firms' decision process is addressed by the instrumental variable estimator.

5.3.1 | The 4-step estimation procedure

We follow Bokusheva and Čechura (2017) approach and estimate parameters and error terms of Equations (15) and (16) in the 4-step procedure. For the estimation procedure we rewrite the mark-down and mark-up models as follows:

$$\frac{w_x x_{i,t}}{R_{i,t}} = \beta_0^* + \beta_{xt} t + \beta_{xx} ln x_{i,t} + \beta'_{zx} ln z + g_{1i}^* + \varepsilon_{1i,t}$$
(17)

$$\frac{py_{i,t}}{C_{i,t}} = \alpha_0^* + \alpha_{yt}t + \alpha_{yy}lny_{i,t} + \alpha'_{xy}ln\tilde{x} + g_{2i}^* + \varepsilon_{2i,t},$$
(18)

where

$$\beta_0^* = \beta_0 - E(\eta_i) - E(\mu_{i,t}) \text{ and } \alpha_0^* = \alpha_0 + E(\psi_i) + E(\varsigma_{i,t})$$
(19)

$$g_{1i}^{*} = \beta_{x_{i}} - \eta_{i} + E(\eta_{i}) \text{ and } g_{2i}^{*} = \alpha_{y_{i}} + \psi_{i} - E(\psi_{i})$$
 (20)

and

$$\varepsilon_{1i,t} = \upsilon_{i,t} - \mu_{i,t} + E(\mu_{i,t}) \text{ and } \varepsilon_{2i,t} = e_{i,t} + \varsigma_{i,t} - E(\varsigma_{i,t})$$

(21) with $E(\eta_i) = \sqrt{\frac{2}{\pi}} \sigma_{\eta}$, $E(\mu_{it}) = \sqrt{\frac{2}{\pi}} \sigma_{\mu}$, $E(\psi_i) = \sqrt{\frac{2}{\pi}} \sigma_{\psi}$ and $E(\varsigma_{it}) = \sqrt{\frac{2}{\pi}} \sigma_{\varsigma}$. In this formulation, $g^*_{(.)i}$ and $\varepsilon_{(.)i,t}$ are random variables with zero means and constant variances.

1st step: we use the two-step system GMM estimator (Arellano & Bover, 1995; Blundell & Bond, 1998) to receive unbiased parameters β and α from Equations (17) and (18).

The GMM estimator is applied on the Equations (17) and (18) considering the composite error term: $\epsilon_{1i,t} = g_{1i}^* + \epsilon_{1i,t}$ and $\epsilon_{2i,t} = g_{2i}^* + \epsilon_{2i,t}$, respectively. Bokusheva et al. (2023) show that neither g_{1i}^* nor $\mu_{it} + E(\mu_{it})$ and ν_{it} correlate with regressors in Equation (17). The same is true for model (18).

In general, system GMM¹⁴ estimates a model in both differences and levels and employs two types of instruments: the level instruments for the differenced equations and the lagged differences for the equations in levels (Arellano & Bover, 1995). Estimating the model in differences in any case controls for firm-specific time-invariant effect and addresses the problem of weak instruments in the standard GMM approach (Blundell & Bond, 1998; Mairesse & Hall, 1996). Moreover, GMM-type instruments are uncorrelated (in principle) with the composed error term. System GMM estimator allows lagged values of model variables to be used as instruments.¹⁵ The variables in the model might be exogenous/predetermined/endogenous. Exogenous variables can be used as instrumental variables (IV). Predetermined variables, which are not strictly exogenous, are standardly used with lags 1 and longer and endogenous variables with lags 2 and longer (Roodman, 2009). The IV approach takes care of the correlation of not only the random effects with the variable inputs but also the correlation with other error terms. Finally, the correct selection of instruments is tested using Hansen (1982) J-test.

2nd step: the GMM residuals from the equation in levels are employed in the estimate of the random effects model using the Generalized Least Squares (GLS) estimator. In particular, ignoring the difference between the true and estimated parameters (which is standard in multistep procedure), the residuals can be written as: $\hat{r}_{1i,t} = g_{1i}^* + \varepsilon_{1i,t}$ and $\hat{r}_{2i,t} = g_{2i}^* + \varepsilon_{2i,t}$, respectively. Since $g_{(.)i}^* + \varepsilon_{(.)i,t}$ are zero-mean random variables, we may apply random effects model with no regressors to obtain their predicted values.

¹³ The details on the distributional assumptions are provided, for example, by Kumbhakar and Lovell (2000) and Kumbhakar et al. (2015).

¹⁴ In general, GMM estimates the model parameters directly from the moment conditions, without imposing any conditions on the distribution of the error term.

¹⁵This feature is valuable in situations when data does not provide external instruments.

3rd step: predicted values of $g^*_{(.)i}$ are used in the estimation of stochastic frontier model to obtain the estimates of persistent component:

$$\hat{g}_{1i}^{*} = \beta_{x_{i}} - \eta_{i} + E(\eta_{i}) \text{ and } \hat{g}_{2i}^{*} = \alpha_{y_{i}} + \psi_{i} - E(\psi_{i})$$
 (22)

Given the distributional assumptions of persistent and heterogeneity component: $\eta_i \sim N^+(0, \sigma_{\eta}^2)$, $\beta_{x_i} \sim N(0, \sigma_{\beta}^2)$, $\psi_i \sim N^+(0, \sigma_{\psi}^2)$ and $\alpha_{y_i} \sim N(0, \sigma_{\alpha}^2)$, respectively, with $E(\eta_i) = \sqrt{\frac{2}{\pi}} \sigma_{\eta}$ and $E(\psi_i) = \sqrt{\frac{2}{\pi}} \sigma_{\psi}$, we can estimate models in Equation (22) using the standard normal-halfnormal stochastic frontier model cross-sectionally. Then, by applying Jondrow et al. (1982) procedure, we obtain estimates of η_i and ψ_i .

4th step: in this step we may estimate transient components following a similar procedure as in the step 3 with predicted values $\varepsilon_{(\lambda)i,t}$.¹⁶

Finally, defining the relative mark-down in Equation (5) and relative mark-up in Equation (10), they can be estimated as:

$$\widehat{\sigma}_{i} = \frac{\widehat{\eta}_{i}}{\beta_{0} + \beta_{x_{i}} + \beta_{xt}t + \beta_{xx}lnx_{it} + \beta'_{zx}lnz}$$
(23)

and

$$\widehat{\varphi_i} = \frac{\widehat{\psi_i}}{\alpha_0 + \alpha_{y_i} + \alpha_{y_t}t + \alpha_{yy}lny_{it} + \alpha'_{xy}ln\,\widetilde{x}} \qquad (24)$$

The estimated mark-down/up can be interpreted as a measure of the significance of the dynamics and extent of market power in the tomato supply chain.

As we have processing cooperatives in the Italian tomato industry, the profit maximization model which is explained above can be criticized due to behavioral assumption. However, there are clear examples that profit maximization assumption can be considered for cooperatives. For instance, Conserve Italia or Consorzio Casalasco del Pomodoro (CCDP) which are categorized as cooperatives, have a high share of the processing market (see Table 1) and they can be categorized as profit maximization entities. The EU-commissioned study in 2012 concluded that Conserve Italia (with 8.11% share from the industry in 2018) is not a classical cooperative (Bono & Iliopoulos, 2012). Therefore, the Italian cooperative system can be characterized as a business model that does not contradict the behavioral assumption in this study.

Moreover, the employed method above provides robust estimates of the relative mark-up and mark-down in the frame of the theoretical framework even with cooperatives in the sample since our right-hand sides of the models relate to the firm technology (see the first derivative of the respective distance function). Even in the case of cooperatives, it is a standard in the literature to use distance functions to estimate the production technology (see e.g., Skevas & Grashuis, 2023). Finally, we allow for heterogeneity in the firm technology.

6 | RESULTS

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Tables 3 and 4 provide the parameter estimates of the mark-down and mark-up models for the Italian tomato food processing sector. All the fitted parameters are statistically significant at a 5% significance level, except for time in the mark-down model and normalized labor in the mark-up model, which is, however, statistically significant at a 10% significance level. Moreover, the Arellano-Bond test for AR(2) in first differences, as well as the Hansen test of over identified restrictions, shows the validity of the models and the correct selections of the employed instruments, respectively.

In the case of the mark-down model, the fitted parameters show that labor (ln_L) and capital (ln_C) have a negative impact on the material cost share $(\frac{w_x x_{i,t}}{R_{i,t}})$ and material inputs (ln_M) contribute positively. The material cost share does not change significantly over time (t). The negative impacts of capital and labor inputs together with the positive contribution of the material inputs correspond with our expectations, suggesting that larger companies may produce with higher relative value added.

As far as the mark-up model is concerned, the fitted parameters show that the output (ln_y) and normalized material inputs (ln_nM) have a negative impact on the revenue share $(\frac{py_{i,t}}{C_{i,t}})$. On the other hand, normalized labor inputs (ln_nL) positively determine the revenue share. This result corresponds with the estimates of the markdown model. The significant positive coefficient on the time variable (t) indicates that the revenue share increases over time. In addition to the previous conclusion, this implies that relative value added has been increasing in the study period.

Finally, the parameter estimates in the second, third, as well as fourth steps are highly significant and provide good overall statistical and econometric quality for both models. In particular, the random effects models show that the variation of one-sided components are more pronounced than the variation in the random component. Moreover, the estimates of the persistent part of the one-sided

¹⁶ Since we do not use transient components in our analysis we refer for details on calculations to Bokusheva and Čechura (2017) and Bokusheva et al. (2023).

ECONOMICS

TABLE 3 Mark- down model.

		Standard	
Variable	Coefficient	deviation	P-value
t	.000	.001	.682
ln_M	.083	.013	.000
ln_L	043	.012	.001
ln_C	023	.009	.009
Constant	.368	.037	.000
			P-value
AR(2)		.02	.982
Hansen test of overid. res	strictions: chi2 (78)	84.83	.876
Number of observations:	924		

Source: Own calculations.

TABLE 4 Mark-up model.

		Standard	
Variable	Coefficient	deviation	P-value
t	.004	.002	.041
ln_y	045	.015	.003
ln_nL	.061	.031	.050
ln_nM	085	.036	.019
Constant	-1.919	.125	.000
			P-value
AR(2)		.18	.854
Hansen test of overid. res	strictions: chi2 (78)	92.96	.540
Number of observations:	999		

Source: Own calculations.

TABLE 5Summary statistics of mark-down and mark-upestimations.

	Mean	Standard deviation	Minimum	Maximum
Relative mark-down	.216	.091	.000	.472
Relative mark-up	.168	.104	.000	.579

Source: Own calculations.

component indicate that differences in the noncompetitive behavior among Italian tomato processors are important characteristics of this industry.¹⁷

Table 5 provides statistical characteristics of the relative mark-down and relative mark-up. For the relative markdown, zero indicates no market imperfections or generally competitive behavior, as the case in a situation where the marginal revenue product equals the price of the material inputs (especially agricultural raw materials, which domi-

¹⁷We have skipped presenting the other step estimations due to space limitations, but they can be provided upon request.

nate the material inputs in the analyzed tomato processing industry).

A positive value of the relative mark-down thus represents non-competitive behavior. In particular, an increasing relative mark-down is associated with increasing market imperfections or, in general, increasing abuse of market power, that is, the food processor has a greater degree of oligopsonistic power (e.g., due to higher bargaining power) to charge mark-down ($MRP_x > w_x$) with respect to suppliers (in this case farmers); see Equation (5). Another interpretation of the $MRP_x > w_x$ is in terms of game theory, that is, the coordination of a firm's pricing behavior–collusion.

With respect to the different interpretation of the surplus of marginal revenue product over the input price, we may relate the increase in relative mark-down to an increase in the degree of non-competitive behavior, which is more general compared to the increase in what's been interpreted as oligopsonistic power.¹⁸ However, as we demonstrate in Equation (5), where we derive the

¹⁸ The interpretation in terms of oligopsonistic power can be misleading; see, for example, Ivaldi et al. (2003, p.50).

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FIGURE 3 Histogram of the estimated mark-downs and mark-ups including the nominal and weighted calculated averages. *Source:* Own calculations; figure made with ggplot2 (Wickham, 2016).

relationship between mark-down component and indicator of market power, assuming constant supply elasticity (ε_x), the change in mark-down component implies the change in market power in input market.

Analogically, zero value of the relative mark-up indicates competitive behavior and market imperfections increase with increasing mark-up; see Equation (10). Moreover, derived Equation (10) implies that the change in mark-up component can be associated with the change in market power if the demand elasticity does not change. The results indicate some degree of non-competitive behavior in both the input as well as output markets. However, the market imperfections are more pronounced in the input processing markets, that is, in the relation between farmers and processors.

The distributions of both the relative mark-down and relative mark-up are relatively narrow, with standard deviations of .091 and .104, respectively, and are slightly skewed towards smaller values. The histogram of estimated markdowns and mark-ups with nominal and weighted average can be seen in Figure 3. These figures indicate that only a small number of companies are characterized by a considerably high degree of non-competitive behavior.¹⁹



FIGURE 4 Annual relative weighted mark-down and mark-up estimation.

Source: Own calculations; figure made with ggplot2 (Wickham, 2016).

Figure 4 shows that the relative weighted mark-down indicates higher market imperfections on the input market when considering revenues as weights as compared to the standard sample mean in Table 5. We may then observe a

this objective. In order to test this critical point, we have re-estimated the mark-up and mark-down models without considering the available cooperatives in the sample. The results are approximately the same as the full model which show the robustness of our results. These estimations are provided in Appendix 3 in Tables A3.1, A3.2 and A3.3.

¹⁹ One critical issue in this analysis is hypothesizing on the profit maximization objective which is followed in this article. We can assume that available cooperatives in the tomato processing industry may not follow

AGRICULTURAL ECONOMICS

615

TABLE 6Relative mark-down and mark-up according to thesize.

	Relative mark-down		Relative mark-up	
Size	Standard Mean deviation		Mean	Standard deviation
Small	.267	.007	.135	.010
Medium	.210	.005	.125	.005
Large	.211	.004	.198	.004
Very large	.222	.016	.298	.015

Source: Own calculations.

decline in the relative mark-down from 2007 until 2016 and an increase afterwards. While the decline may be related to the creation and operation of IBOs, the observed change in increasing trend may be associated with increasing market concentration starting in 2015 (see Figure 2).

The weighted relative mark-up (see Figure 4) provides similar information about the market imperfections on the output market as is the case for the input tomato processing market. First, market imperfections are more pronounced when using revenues as weights. We may again observe a decreasing trend in the relative mark-up from 2007 until 2016 and an increase in 2017 and 2018. The decreasing mark-up suggests that despite higher concentration, the processors might lose the bargaining power on the output market. However, the relationship between the retailers and processors and the changes in the size of the retail entities are issues of further study which is out of the boundaries of this article. We can only say that we observe a sort of reduction of the mark-up of the processing units on average.

Table 6 presents the figures on the relative mark-down and relative mark-up according to the size of the company. As opposed to our expectations, small companies have higher mark-down in the input market as compared to medium, large and very large companies that have similar mean values of the index. On the other hand, the distribution of the mark-up for the output market indicates higher mean values for large and very large companies, which is in line with our expectations about the higher bargaining power of larger companies.

7 | DISCUSSION

This analysis shows support for the notion that there have been changes over time in the degree of market imperfections in the input and output tomato processing market. The balance between competitive and non-competitive behavior between tomato processing chain actors is a crucial aspect in the development, evolution, and sustainability of the chain. The tomato processing chain management has addressed the need to mitigate the economic difficulties that some of the actors of the Italian tomato chain was encountering and ensures adequate tomato production and commercialization stability.

This research results support the existence of a significant change around the years 2007 and 2016. This result may be explained by the evolution of the relationships among the tomato processing chain actors since the end of 2006. Tomato producers and processors were undergoing a time of crisis in the 2000s and developed strategies at the chain level that officially eventually led to the formation of an official body (IBO) in 2011 based on the concept of mutual support.

The upstream and downstream tomato processing chain dynamics support the interpretation of the results of the present research. Upstream in the chain, the actors' relationships are aimed at strengthening market concentration and social collaboration between the actors. The aim is to achieve a higher competitiveness and ensure the stability of the mutual dependability between the producers and processors. In this regard, the timeline of the gradual shaping of the IBOs during 2007-2011 is in line with the decreasing weighted average of the mark-down and mark-up index we found in this study (see Figure 4). Upon this coordination, the producers committed to limiting the number of hectares for tomato production, in agreement with the processors. This is aimed at ensuring an adequate balance between the available tomatoes and the forecasted processed tomatoes that the processors expect to sell, which depends on market sales projections and stock availability that may be at the disposal of processors from previous years. Limiting tomato production avoids overproduction and thus allows keeping the price level high.

This agreement is founded on a commonly defined reference price that both parties are aware of when signing a contract. This price can be adjusted depending on quality standards and on one-to-one contractual negotiations that sets both parties free. This negotiation dynamic is renewed yearly and ensures trade relationships that remain quite stable over time. We may say that tomato producers and processors aim at strengthening both producers' and processors' competitiveness by finding agreements that may be beneficial for both parties and by anticipating difficulties that may hinder all actors (Crespi & MacDonald, 2022; Merkle et al., 2021).

Processors need raw materials produced according to respected quality standards and ensured timing and farmers need to know they will sell their products according to a set price. Mutual collaborative trust is at the basis of this relationship (Lee & Van Cayseele, 2022; Sorrentino et al., 2018). Some relationships between producers and the processing industry have existed for a long time, are oriented to be long-term, and are based on collaboration WILEV

and trust. Furthermore, this allows for innovation and improvements to be implemented along the supply chain thanks to a good level of collaboration.

This finding confirms the Modern Agricultural Market (MAM) concept of Sexton (2013) and tomato processors consider their long-term relationship with tomato producers in order to secure the availability of raw materials. However, our results are also in-line with the timeline of events happening since the end of 2015, which were the merging and increase of concentration in the Italian tomato industry (see Figure 2). As the concentration increases, the level of market imperfections increases in the presence of IBOs, which shows that the new supply chain governance with IBOs constantly faces some challenges and requires adjustments to consolidate the effectiveness of the established instruments. The current research supports the idea that there has been limitations in the market power imbalances and that market imperfections may be reallocated. Part of these achievements may be the result of mutual knowledge and awareness based on the long-term relationship and acknowledgment of reciprocal dependency.

8 | CONCLUSION

In this study we have used mark-up and mark-down models, which have theoretical roots in New Industrial Organization (NIO), to test the market imperfections in the Italian tomato processing sector. Financial data from a sample of tomato processing firms is used for this study covering the 2006–2018 period. A stochastic frontier model was used for the model estimation and a timeline of important events in this supply chain was illustrated. It is made evident that two major events, the shaping the Interbranch Organization (IBO) during 2007–2011 and the increase in the level of concentration of the major processors after 2015, had an impact on the tomato supply chain. We found that the market imperfections decreased after the shaping of IBOs and increased again as concentration increased.

The tomato processing case analyzed in the present research shows that the sustainability, integrity and resilience of the supply chain is related to the managerial governance of the chain. Chain actors can thus contribute to finding a balance between competition and collaboration, so all chain actors can reach a higher level of competitiveness. Relationships within and outside the chain may vary over time as they are exposed to new challenges and relevant initiatives have to thus be dynamic and responsive. This research did not cover the developments after the 2019 period. Future studies can further expand the period of analysis by including years with possibly relevant external events that may impact on the tomato supply chain, such as COVID 19 pandemic or Ukrainian war.

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CONFLICT OF INTEREST STATEMENT The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data we use in the analysis is drawn from the Amadeus database (since 2021 Orbis Europe) that is created and sold by Bureau van Dijk. They cannot be shared due to copyrights. The data can be shared only upon the official permission of the copyright holder.

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REFERENCES

- ANICAV. (2020, November 3). Pomodoro da industria: Campagna di trasformazione 2020. Associazione Nazionale Industriali Conserve Alimentari Vegetali (ANICAV). https://anicav.it/2020/11/03/ pomodoro-da-industria-campagna-di-trasformazione-2020/
- Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1), 29–51. https://doi.org/10.1016/0304-4076(94) 01642-D
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8
- Bokusheva, R., & Čechura, L. (2017). Evaluating dynamics, sources and drivers of productivity growth at the farm level. In *Documents de Travail de l'OCDE Sur l'Alimentation, l'Agriculture et Et les Pêcheries* (Issue 106). https://doi.org/10.1787/5f2d0601-en

617

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AGRICULTURA ECONOMICS

- Bokusheva, R., Čechura, L., & Kumbhakar, S. C. (2023). Estimating persistent and transient technical efficiency and their determinants in the presence of heterogeneity and endogeneity. *Journal of Agricultural Economics*. https://doi.org/10.1111/1477-9552. 12512
- Bono, P., & Iliopoulos, C. (2012). Support for Farmers' Cooperatives, Case Study Report Internationalisation of Second-tier Cooperatives: The Case of Conserve Italia, Italy. Wageningen UR. https://www.agreri.gr/en/content/support-farmerscooperatives-case-study-report-internationalisation-second-tiercooperatives?qt-relevant_sources=1
- Bresnahan, T. F. (1982). The oligopoly solution concept is identified. *Economics Letters*, 10(1–2), 87–92. https://doi.org/10.1016/ 0165-1765(82)90121-5
- Bresnahan, T. F. (1989). Empirical studies of industries with market power. In *Handbook of Industrial Organization* (Vol., 2, pp. 1011– 1057). Elsevier.
- Busch, G., & Spiller, A. (2016). Farmer share and fair distribution in food chains from a consumer's perspective. *Journal of Economic Psychology*, 55, 149–158. https://doi.org/10.1016/j.joep.2016.03.007
- Cakir, M., & Balagtas, J. V. (2012). Estimating market power of U.S. dairy cooperatives in the fluid milk market. *American Journal of Agricultural Economics*, 94(3), 647–658. https://doi.org/10.1093/ajae/aar136
- Clapp, J. (2021). The problem with growing corporate concentration and power in the global food system. *Nature Food*, *2*(6), 404–408. https://doi.org/10.1038/s43016-021-00297-7
- Crespi, J. M., & MacDonald, J. M. (2022). Chapter 87 Concentration in food and agricultural markets. In C. B. Barrett & D. R. Just (Eds.), *Handbook of agricultural economics* (1st ed., Vol., 6, pp. 4781–4843). Elsevier. https://doi.org/10.1016/BS.HESAGR.2022.03. 003
- Deconinck, K. (2021). Concentration and market power in the food chain (No. 151; OECD Food, Agriculture and Fisheries Papers). https://doi.org/10.1787/18156797
- Donati, M., Guareschi, M., & Veneziani, M. (2019). Organic tomatoes in Italy. In Sustainability of European Food Quality Schemes: Multi-Performance, Structure, and Governance of PDO, PGI, and Organic Agri-Food Systems (pp. 171–189). Springer International Publishing. https://doi.org/10.1007/978-3-030-27508-2_9
- Dong, X., Balagtas, J. V., & Byrne, A. T. (2023). A closer look at the relationship between concentration, prices, and market power in food retail—A monopolistic competition and differentiated products approach. *Applied Economic Perspectives and Policy*. https:// doi.org/10.1002/aepp.13344
- European Commission. (2022, August 2). Tomatoes statistics. EU Portal. https://agriculture.ec.europa.eu/data-andanalysis/markets/overviews/market-observatories/fruit-andvegetables/tomatoes-statistics_en
- Fałkowski, J., Ménard, C., Sexton, J., Swinnen, J., & Vandevelde, S. (2017). Unfair trading practices in the food supply chain: A literature review on methodologies, impacts and regulatory aspects (F. Di Marcantonio & P. Ciaian (Eds.)), European Commission, Joint Research Centre. https://doi.org/10.2760/800
- Hansen, L. P. (1982). Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica*, 50(4), 1029. https://doi. org/10.2307/1912775
- Ivaldi, M., Jullien, B., Rey, P., Seabright, P., & Tirole, J. (2003). *The Economics of Tacit Collusion*. European Commission. https://ec.europa.eu/competition/mergers/studies_reports/ the_economics_of_tacit_collusion_en.pdf

- Jondrow, J., Knox Lovell, C. A., Materov, I. S., & Schmidt, P. (1982). On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics*, *19*(2–3), 233– 238. https://doi.org/10.1016/0304-4076(82)90004-5
- Kumbhakar, S. C., Baardsen, S., & Lien, G. (2012). A New Method for Estimating Market Power with an Application to Norwegian Sawmilling. *Review of Industrial Organization*, 40(2), 109–129. https://doi.org/10.1007/s11151-012-9339-7
- Kumbhakar, S. C., & Lovell, C. A. K. (2000). Stochastic Frontier Analysis (1st ed.). Cambridge University Press. https://doi.org/10.1017/ CBO9781139174411
- Kumbhakar, S., Wang, H.-J., & Horncastle, A. P. (2015). A practitioner's guide to stochastic frontier analysis using Stata. Cambridge University Press.
- Lee, H., & Van Cayseele, P. (2022). Market power, markup volatility and the role of cooperatives in the food value chain: evidence from Italy. *European Review of Agricultural Economics*, 00(0), 1–49. https://doi.org/10.1093/ERAE/JBAC001
- Lerner, A. P. (1934). The Concept of Monopoly and the Measurement of Monopoly Power. *The Review of Economic Studies*, *1*(3), 157–175. https://doi.org/10.2307/2967480
- Mairesse, J., & Hall, B. H. (1996). Estimating the Productivity of Research and Development in French and US Manufacturing Firms: An Exploration of Simultaneity Issues with GMM Methods. In (K. Wagner & B. Van Ark Eds.), *International Productivity Differences: Measurement and Explanations* (1st ed., pp. 285–315). Elsevier Science.
- Mantino, F., & Forcina, B. (2018). Market, Policies and Local Governance as Drivers of Environmental Public Benefits: The Case of the Localised Processed Tomato in Northern Italy. *Agriculture*, 8(3), 34. https://doi.org/10.3390/agriculture8030034
- Mérel, P. (2011). Institutional Market Power in Comté: Insights from a 'Double Marginalisation' Model. *Journal of Agricultural Economics*, 62(3), 585–603. https://doi.org/10.1111/j.1477-9552.2011. 00301.x
- Mérel, P., & Sexton, R. J. (2017). Buyer power with atomistic upstream entry: Can downstream consolidation increase production and welfare? *International Journal of Industrial Organization*, 50, 259–293. https://doi.org/10.1016/j.ijindorg.2016.11.002
- Merkle, M., Moran, D., Warren, F., & Alexander, P. (2021). How does market power affect the resilience of food supply? *Global Food Security*, 30, 100556. https://doi.org/10.1016/j.gfs.2021.100556
- Muth, M. K., & Wohlgenant, M. K. (1999). Measuring the degree of oligopsony power in the beef packing industry in the absence of marketing input quantity data. *Journal of Agricultural and Resource Economics*, 24(2), 299–312.
- NIPTIO. (2020). Statuto Organizzazione Interprofessionale "OI Pomodoro Da Industria Nord Italia." OI Pomodoro Da Industria Nord Italia (North of Italy Processed Tomato Interbranch Organization). https://oipomodorocentrosud.it/protocollo-oipomodoro-da-industria-nord-italia/
- NIPTIO. (2021a). Dati. OI Pomodoro Da Industria Nord Italia (North of Italy Processed Tomato Interbranch Organization). https:// oipomodoronorditalia.it/dati/#prodotti_finiti
- NIPTIO. (2021b, January 13). CHI SIAMO. OI Pomodoro Da Industria Nord Italia (North of Italy Processed Tomato Interbranch Organization). https://oipomodoronorditalia.it/chi-siamo/#cosafacciamo
- Roodman, D. (2009). How to do Xtabond2: An Introduction to Difference and System GMM in Stata. *The Stata Journal*, *9*(1), 86–136. https://doi.org/10.1177/1536867x0900900106

ECONOMICS

- Samoggia, A., Grillini, G., & Del Prete, M. (2021). Price Fairness of Processed Tomato Agro-Food Chain: The Italian Consumers' Perception Perspective. *Foods*, 10(5), 984. https://doi.org/10.3390/ foods10050984
- Samoggia, A., Monticone, F., & Esposito, G. (2022). Governance in the Italian Processed Tomato Value Chain: The Case for an Interbranch Organisation. *Sustainability*, 14(5), 2749. https://doi.org/10. 3390/su14052749
- Sexton, R. J. (2013). Market power, misconceptions, and modern agricultural markets. *American Journal of Agricultural Economics*, 95(2), 209–219. https://doi.org/10.1093/ajae/aas102
- Sexton, R. J., & Xia, T. (2018). Increasing concentration in the agricultural supply chain: implications for market power and sector performance. *Annual Review of Resource Economics*, 10(1), 229–251. https://doi.org/10.1146/annurev-resource-100517-023312
- Shephard, R. W. (1970). *Theory of cost and production functions*. Princeton University Press.
- Skevas, T., & Grashuis, J. (2023). Evaluating dynamic productivity change of US farm supply cooperatives. *Agribusiness*, Early View. https://doi.org/10.1002/AGR.21812
- Sorrentino, A., Russo, C., & Cacchiarelli, L. (2018). Market power and bargaining power in the EU food supply chain: The role of producer organizations. *New Medit*, 17(4), 21–31. https://doi.org/ 10.30682/nm1804b
- Tomato News. (2021a). Architecture of world trade in 2020/2021. Tomato News. https://www.tomatonews.com/en/trade_46.html
- Tomato News. (2021b, January 21). *The global tomato processing industry*. Tomato News. https://www.tomatonews.com/en/ background_47.html
- Tomato News. (2021c). The global tomato processing industry. Tomato News. https://www.tomatonews.com/en/background_47.html
- Tomato News. (2017). *Italy: COPADOR permanently taken over by Mutti*. Tomato News. https://www.tomatonews.com/en/italy-copador-permanently-taken-over-by-mutti_2_194.html
- Tomato News. (2018, November 8). *Italy: Italtom purchases ex-Ferrara Food*. Tomato News. https://www.tomatonews.com/en/ italy-italtom-purchases-ex-ferrara-food_2_539.html
- Tsionas, E. G., & Kumbhakar, S. C. (2014). Firm heterogeneity, persistent and transient technical inefficiency: A generalized true random-effects model. *Journal of Applied Econometrics*, 29(1), 110–132. https://doi.org/10.1002/jae.2300
- Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Springer Nature. https://doi.org/10.1007/978-3-319-24277-4
- Zhou, P., Zhou, X., & Fan, L. W. (2014). On estimating shadow prices of undesirable outputs with efficiency models: A literature review. *Applied Energy*, 130, 799–806. https://doi.org/10.1016/ J.APENERGY.2014.02.049

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APPENDIX A1: OUTPUT DISTANCE FUNCTION AND MARK-DOWN MODEL SPECIFICATION

ČECHURA ET AL.

If we assume a joint-production process with the input vector $\mathbf{x} \in \mathfrak{R}^J_+$ to produce the output vector $\mathbf{y} \in \mathfrak{R}^M_+$, then the production technology can be expressed by the output possibility set $P(\mathbf{x}) = \{\mathbf{y} : \mathbf{x} \text{ can produce } (\mathbf{y})\}$. The output possibility set is supposed to be closed, convex and bounded by the output isoquant Isoq $P(\mathbf{x}) = \{\mathbf{y} : \mathbf{y} \in P(\mathbf{x}), \lambda(\mathbf{y}) \notin P(\mathbf{x}), \lambda > 1\}$ and the inputs as well as outputs are supposed to be strongly, or freely, disposable (for more reference see Kumbhakar & Lovell, 2000). Then, Shephard's output distance function (Shephard, 1970) is a radial measure of the distance from output vector \mathbf{y} to Isoq $P(\mathbf{x})$:

 $D_O(\mathbf{x}, \mathbf{y}) = \inf \left\{ \theta > 0 : (\mathbf{y}/\theta) \in P(\mathbf{x}) \right\}, \qquad (A.1)$

where θ measures the maximum degree of the proportional increase of *y* for given *x* (Zhou et al., 2014).

If we assume that the output distance function has a translog form, we can write²⁰:

$$ln D^{0} = \beta_{0} + \beta_{t}t + \frac{1}{2}\beta_{tt}t + \beta_{x}lnx + \beta_{xt}lnxt + \frac{1}{2}\beta_{xx}(lnx)^{2} + \beta_{z}'lnz + \beta_{zt}'lnzt + \frac{1}{2}lnz'B_{zz}lnz + lnz'\beta_{zx}lnx + \beta_{y}'lny + \beta_{yt}'lnyt + \frac{1}{2}lny'B_{yy}lny + lny'\beta_{yx}lnx + lny'B_{yz}lnz$$
(A.2)

The first derivative of Equation (A.2) with respect to material inputs is:

$$\frac{\partial \ln D^0}{\partial \ln x} = \beta_x + \beta_{xt}t + \beta_{xx}\ln x + \beta'_{zx}\ln z + \beta'_{yx}\ln y \quad (A.3)$$

Using Equations (A.3) in relation $(6)^{21}$ we get:

$$\frac{w_x x}{R} \le \beta_x + \beta_{xt} t + \beta_{xx} \ln x + \beta'_{zx} \ln z + \beta'_{yx} \ln y \quad (A.4)$$

The output distance function is homogenous of degree 1 in outputs. Therefore, we impose homogeneity restriction by normalising all the outputs by one output to get the empirical representation of Equation (4) to be estimated:

$$\frac{w_x x}{R} \le \beta_x + \beta_{xt} t + \beta_{xx} \ln x + \beta'_{zx} \ln z + \beta'_{yx} \ln \tilde{y} \quad (A.5)$$

where $\tilde{y}_m = y_m / y_M$ for $m = 1, \dots, M$.

²⁰ To follow the main body of the article, we split the vector of input **x** into: agricultural raw materials (**x**) and vector of other inputs (**z**). ²¹ To recall relation (6) from a main body of the article:

$$w_x \frac{x}{R} \le MRP_x \frac{x}{R} = \frac{\partial R}{\partial x} \frac{x}{R} = \frac{\partial lnR}{\partial lnx} = \frac{\partial lnD^0}{\partial lnx}$$

For one output, (A.5) reduces to (homogeneity of degree 1 in outputs requires that $\beta_{vx} = 0$):

$$\frac{w_x x}{R} \le \beta_x + \beta_{xt} t + \beta_{xx} \ln x + \beta'_{zx} \ln z \qquad (A.6)$$

The inequality in (A.5) can be transformed to the equality adding a non-negative one-sided error term u:

$$\frac{w_x x}{R} = \beta_x + \beta_{xt} t + \beta_{xx} \ln x + \beta'_{zx} \ln z - u, \ u \ge 0,$$
(A.7)

which is a representation of the mark-down model in Equation (13) in the main body of the article.

APPENDIX A2: INPUT DISTANCE FUNCTION AND MARK-UP MODEL SPECIFICATION

The production technology can be alternatively expressed by the input requirement set $L(\mathbf{y}) = \{\mathbf{x} : \mathbf{x} \text{ can produce } \mathbf{y}\}$, with the input vector $\mathbf{x} \in \mathfrak{R}^J_+$ to produce the output vector $\mathbf{y} \in \mathfrak{R}^M_+$. The input requirement set is supposed to be closed, convex and bounded by the input isoquant Isoq $L(\mathbf{y}) = \{\mathbf{x} : \mathbf{x} \in L(\mathbf{y}), \lambda(\mathbf{x}) \notin L(\mathbf{y}), \lambda < 1\}$ and the inputs as well as outputs are supposed to be strongly, or freely, disposable (for more reference see again Kumbhakar & Lovell, 2000). Shephard's input distance function (Shephard, 1970) is then a radial measure of the distance from output vector \mathbf{y} to Isoq $L(\mathbf{y})$:

$$D_{I}(\boldsymbol{y},\boldsymbol{x}) = \sup \{ \mu > 0 : (\boldsymbol{y}/\mu) \in L(\boldsymbol{y}) \}, \qquad (A.8)$$

where μ measures the maximum degree of proportional reduction of **x** for given **y** (Zhou et al., 2014).

Assuming that the input distance function with one output has a translog form:

$$ln D^{I} = \alpha_{0} + \alpha_{t}t + \frac{1}{2}\alpha_{tt}t^{2} + \alpha_{y}lny + \alpha_{yt}lnyt + \frac{1}{2}\alpha_{yy}(lny)^{2} + \alpha'_{x}\ln x + \alpha'_{xt}\ln xt + \frac{1}{2}lnx'A_{xx}lnx + lnx'A_{xy}lny,$$
(A 9)

the first derivative of equation (A.9) with respect to output is:

$$\frac{\partial \ln D^{I}}{\partial \ln y} = \alpha_{y} + \alpha_{yl}t + \alpha_{yy}\ln y + \alpha'_{xy}\ln x \qquad (A.10)$$

Consequently, using Equation (A.10) in relation $(11)^{22}$

²² To recall relation (11) from a main body of the article:

$$\frac{p.y}{C} \ge \frac{\partial C(\boldsymbol{w}, y_i, t)}{\partial y_i} \cdot \frac{y}{C} = \frac{\partial lnC}{\partial lny} = \frac{\partial lnD^I}{\partial lny}$$

we get:

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$$\frac{p \cdot y}{C} \ge \alpha_y + \alpha_{yt}t + \alpha_{yy}\ln y + \alpha'_{xy}\ln x$$
(A.11)

The input distance function is homogenous of degree 1 in inputs. Homogeneity is imposed by normalising all the inputs by one input. Therefore, the empirical representation of (A.11) is:

$$\frac{p \cdot y}{C} \ge \alpha_y + \alpha_{yt}t + \alpha_{yy}\ln y + \alpha'_{xy}\ln \widetilde{x}$$
(A.12)

where $\tilde{x}_j = x_j / x_J$ for $j = 1, \dots, J$.

Transforming inequality (A.12) to the equality by adding a non-negative one-sided error term ε we get:

$$\frac{p \cdot y}{C} = \alpha_y + \alpha_{yt}t + \alpha_{yy}\ln y + \alpha'_{xy}\ln \widetilde{x} + \varepsilon, \ \varepsilon \ge 0,$$
(A.13)

which is a representation of the mark-up model in Equation (14) in the main body of the article.

APPENDIX A3: MARK-DOWN AND MARK-UP ESTIMATION WITHOUT COOPERATIVES

Tables A3.1 and A3.2 provide the parameter estimates of the mark-down and mark-up models for the Italian tomato food processing sector without considering the cooperatives. Table A3.3 provides statistical characteristics of the relative mark-down and relative mark-up. The results of these estimations are approximately similar to the full models.

TABLE A3.1 Mark- down model without cooperatives.

		Standa	rd		
Variable	Coefficient	deviati	on	<i>P</i> -value	
t	.000	.001		.577	
ln_M	.085	.011		.000	
ln_L	043	.012		.001	
ln_C	023	.009		.013	
Constant	.351	.028		.000	
				P-value	
AR(2)			.04	.965	
Hansen test of overid. restrictions: chi2(63) 69.53 .267					
Number of observations: 893					

Source: Own calculations.

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AGRICULTURAL ECONOMICS The Journal of the Internation

TABLE A3.2 Mark-up model without cooperatives.

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Variable	Coefficient	Standa deviati	rd on	P-value	
t	.004	.002		.054	
ln_y	041	.015		.006	
ln_nL	.053	.034		.123	
ln_nM	069	.036		.056	
Constant	-1.871	.121		.000	
				P-value	
AR(2)			.30	.766	
Hansen test o	.680				
Number of observations: 955					

TABLE A3.3Summary statistics of mark-down and mark-upestimations without cooperatives.

	Mean	Standard deviation	Minimum	Maximum
Relative mark-down	.217	.003	.000	.476
Relative mark-up	.164	.003	.000	.619

Source: Own calculations.

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Source: Own calculations.