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Research article

Causal loop diagrams to systematically analyze market power in the Belgian sugar value chain

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Abstract: It has been acknowledged that power is a fundamental aspect that needs to be considered when performing a value chain analysis. The structure of the value chain is indicative of the power distribution along the chain. By employing systems thinking the structure of the value chain can be further investigated and inferences on market power issues can be made. This novel approach connects value chain research with insights from Industrial Organization (IO) literature. Depending on the case, market power may not be measurable by traditional economic tools. Systems thinking offers an alternative tool, allowing the employment of qualitative and quantitative data, overcoming drawbacks of IO methods and providing more depth to value chain analysis. In this paper the valuable contribution of systems thinking to market power analysis is exemplified by the Belgian sugar beet case. The analysis showed that transportability and perishability of sugar beet are key causes of market failure in the Belgian sugar value chain. Systems thinking can support understanding potential future behavior of the market based on the thorough understanding of the current market structure. We illustrate how to integrate factors determining the market structure into causal loop diagrams. This novel approach allows a comprehensive evaluation and thus opens up market power analysis to interdisciplinary research.

Keywords: market power; systems thinking; causal loop; agriculture; sugar

Abbreviations: IO: Industrial Organization; NEIO: New Empirical Industrial Organization; SCP: Structure Conduct Performance

1. Introduction

The increasing concentration in the agro-food system is a process captured by the corporate food regime (which can be subsumed under the third food regime [1]). While governments try to prevent companies from exercising illegal forms of market power, more subtle ways of market power exist, that soon will also be banned in the European Union [2].

Market power estimations are often based on the market concentration. However, empirical studies provide mixed results regarding the adverse effects of market concentration [3]. Moreover, market share alone may not be a sufficient condition for exerting market power. For example, competition among a few large companies might still not allow to charge a mark-up. Also, concentration at one point of the value chain may be counterbalanced by concentration up and / or downstream the value chain, as the example of this case study will show. Moreover, the identification of market concentration depends on the market definition [4]. Furthermore, due to the lack of data market power is often hard to estimate [5].

Value chain analysis can be a useful tool to understand value creation and absorption within highly complex global value chains [6] characteristic for the third food regime. The creation and absorption of value is indicative of the power structure within the value chain. Gereffi, Humphrey [6] and Cox et al. [7] illustrate the importance of understanding the power distribution along the value chain. According to Cox, Sanderson [7], mapping the value chain is not enough. Only by understanding the power structure within the value chain it becomes apparent how and why commodities are produced as well as whether it is worthwhile to participate in the chain.

Gereffi, Humphrey [6] as well as Cox, Sanderson [7] use a qualitative approach to describe the power distribution along the value chain. Critical to their work is that the structure of the chain determines the power distribution. A structure that is caused by factors such as the number of actors or the complexity of transactions. Within Industrial Organization (IO) economics the Structure Conduct Performance (SCP) paradigm supports the idea that the structure of the market affects power. However, due to endogeneity problems the SCP paradigm has been criticized [8], and replaced by the New Empirical Industrial Organization (NEIO) framework which focuses on conduct, rather than on structure [9]. The NEIO framework is neither without its shortcomings [10] and new research indicates the validity of the SCP paradigm [11]. Thus, the appropriateness of the two distinct approaches is an ongoing debate.

We do not intend to participate in this debate, but rather illustrate how systems thinking can be used to analyze market power within a value chain. While the SCP paradigm struggles with the feedback between structure and conduct, systems thinking embraces feedback mechanisms. Moreover, systems thinking supports the understanding of dynamic behavior [12], which are fundamental feature of global value chains [6].

The aim of this paper is to explore the possibility of using systems thinking to study the interrelationships between value chain structure and market power using the sugar beet case study in Belgium. We will show how causal loop diagrams can help structuring complexity and thus support understanding dynamic market power mechanisms caused by the structure of the system. Grether [13], in his review of the usefulness of the SCP approach, assessed the opinion of experts within the field of

IO about the contribution and weakness of as well as future suggestions for IO research. One suggestion for future research within the field of IO was the reexamination and reformulation of the SCP concept through systems analysis. This paper follows this suggestion.

In the remainder of this paper we will first introduce the case study. Next, the method employed will be outlined, and we will explain how we used systems thinking in our analysis as well as how we built causal loop diagrams from qualitative data. The successive section outlines the analysis of the case study by expanding on the causal loop diagram. Finally, results are briefly discussed.

2. Case study introduction: the Belgian sugar value chain

Sugar beet production within Belgium takes up an important role, since it is the crop with the highest production (in tons), occupying 9.2% of the harvest area (55.504 ha) in 2016 [14], distributed among 7.398 sugar beet farms [15]. Despite being an important crop, the number of sugar beet farmers has been declining substantially from 36.114 in 1986. The most pronounced decline of sugar beet farms occurred between 2007 and 2008 due to policy reforms of the sugar quota system, reducing the overall quotas issued. While this reduction led to increased concentration on farm level, the same can be observed on the processing level. In 1872 Belgium hosted 174 sugar beet factories, today only three are left, owned by two companies [16]. Up until the 2015/16 sugar beet campaign market concentration did not pose a problem, due to the regulatory framework within the European Economic Community (EEC) and later the European Union (EU). The quota regulation, that has been in place until September 2017, stabilized prices and sugar beet production within the EU. Over time, regulations were softened, which led to a reduction of guaranteed minimum prices for sugar beet. The reduction of prices should facilitate the transition towards a liberalized market. Regulations not only controlled prices and quantities, but also contractual terms between farmers and refineries. According to the regulations, refineries shall not negotiate with farmers individually, but via the farmers' union[1]. This is a mechanism that particularly now, with the termination of the quota system, supports the creation of a level playing field in this highly concentrated market.

In Belgium, sugar beet farmers have only one sales channel, via the Confederatie van de Belgische Bietenplanters (CBB), which is a Producer Organization that was established in 1965. Its goal is to represent and defend the interests of Belgian sugar beet farmers at local, regional and national level. In this respect one of the most important tasks is to negotiate the sales of the crop to sugar refineries. CBB also controls the reception of the crop in the refineries. This means that in each factory up to five CBB inspectors are permanently present to control the work of the personnel of the sugar refinery and to test whether all reception conditions are fulfilled. They moreover control the pulp and report their results to the farmers [16].

Sugar beet marketing is regulated by interprofessional agreements concluded between each refinery and the farmers' union (CBB). Under the quota regulation, the minimum price was set by the European council of ministers. In this period farmers were certain to sell all their contracted output at least at the minimum price. However, since 2006 the minimum price declined and with the termination of the quota system in September 2017 prices may fall even further. For the plantation year 2017/18 the overall acreage sown with sugar beet has increased by 14% [16]. This together with

[1] Relevant regulations: (EEC) No 741/75, (EC) No 1260/2001, (EC) No 318/2006, (EC) No 1234/2007, (EU) No 1308/2013.

favorable weather conditions led to even higher yields. Sugar beet prices for August 2018 are at an unprecedented low level [17]. It is questionable whether sugar beet cultivation will be profitable, if prices maintain at such a low level. Not only the future strategies of farmers depend on the sugar beet price, but also the strategies of the two refineries. In the marketing year 2016/17 the two refineries had different approaches. While one maintained their past pricing strategy, the price offered by the other was reduced. The coming years will show how prices will develop and whether pricing strategies of refineries will change in accordance.

As sugar beet farmers are faced with falling prices, the creation of value on farm level is of pivotal importance to increase or maintain the profitability of sugar beet cultivation. Accordingly, we apply a value chain perspective in which the farm level is at the center of our analysis. While a supply chain refers to the process of assembling a final product throughout the chain, value chain refers to the creation of value within a chain [6].

3. Method

To unravel the causes of market imperfections, in particular of market power, in the Belgian sugar beet sector, we used a systems thinking approach. The usefulness of systems thinking for the analysis of the agri-food value chain is illustrated by Gereffi, Humphrey [6]. They point out the importance of structure and link it to competition and value creation along the value chain. Gereffi, Humphrey [6] point out that systems maps are a form of representation with two benefits: 'First, it constitutes the framework on which the subsequent stages of the study are built and which ensures that the study meets the necessary criteria of repeatability and comparability; second, it provides the first descriptive result of the technical and functional characteristics that distinguish the specific agri-food system under investigation.'

Similar to the SCP paradigm, systems thinking understands conduct (system behavior) as a result of the structure [9,12]. Thus, both approaches suggest the examination of the structure to infer insights about a specific behavior, such as market power. As we pointed out in the introduction, grounding market power analysis on data struggles with three problems (apart from data availability). First, deviation of price data may not be caused by market power, but by other causes, that may not be apparent to researchers [9,18]. Thus, the results of an analysis may be misinterpreted. The misinterpretation of data relates to the second problem, market power which is not revealed in price data. The discussion pertaining unfair trading practices emphasizes this issue [19]. Third, as Ferguson and Ferguson [9] point out, the analysis of price data resembles a symptom treatment as opposed to treating the cause. Hence, even if data analysis identifies market power, it is not clear what caused market power. Consequently, it does not allow any statement about whether market power will prevail in the future or not, or how to best tackle it. This is, because the underlying cause for market power in the studied market may change. Accordingly, the cause for market power needs to be analyzed, which is following the SCP paradigm the structure of the market. Understanding the structure of the market may also allow policy makers to tackle the root cause of market power in a specific market situation. Thus, the SCP paradigm and systems thinking investigate why there is market power, rather than whether the performance measure (price data) indicates market power.

Following the SCP paradigm the '[S]*tructure* describes the characteristics and composition of markets and industries in an economy' [9]. Mason (1939) identified: a) economic characteristics of the product, b) costs and production characteristics, c) number and relative size of buyers and sellers,

d) knowledge possessed, and e) differences in distribution channels as the building blocks of the structure. However, more building blocks can be added (Ferguson and Ferguson 1994: 14). Systems thinking applies a broader take on the meaning of structure, as the approach is not limited to economic analysis. A structure within systems thinking consists of feedback loops, which are built by the causal relations between variables [12].

The main challenge of the SCP paradigm is endogeneity. In other words, does structure cause conduct, or does conduct cause structure? While the SCP paradigm struggles with this challenge systems dynamics centers around the question of causality [12]. Endogeneity is not a challenge, but the core of systems thinking. Structure and performance variables are connected with each other in causal loop diagrams, allowing the mutual relationship to play out over the course of time. Consequently, a systems thinking analysis may allow to give indications pertaining the future structure and performance of a specific market. For example, an analysis could indicate whether a situation of imperfect competition will prevail in the future, or whether imperfect competition will lead to structural changes that will revert the situation. Hence, while the SCP paradigm needs stable market structures to being applied without facing an endogeneity problem, systems thinking embraces circular causality.

A simple example (Figure 1) serves to explain systems thinking. Figure 1a illustrates a basic causal loop, with two variables, *yield* and *farm gate price*. Within the causal loop diagram, a plus at the end of the arrow signifies that the starting point and the end point of the arrow move in the same direction. A minus, in contrast, means that they are moving in opposite directions. For additional visual clarity the negative arrows have a dashed line. The first simple causal loop should exemplify the concept of positive and negative connections. At the farm level, a certain yield is related to a certain price for that commodity. The higher the yield the lower the price will be, given that the demand stays the same (thus, a negative arrow). In turn, the price feeds back into the yield, since the price will determine how much the farmer will sow the next season. Usually, the higher the price the more will be sown and vice versa (thus, a positive arrow). This relationship builds a balancing feedback loop, indicated with a 'B' in the center of the loop. A loop is balancing if the behavior of the loop does not lead to a collapse, which would be in this case continuously increasing or reducing production. The behavior of the loop is in line with basic economic considerations, where price functions as a balancing mechanism to set supply equal demand. A supplementary feature of this causal relation is a delay between price and output, indicated by two parallel lines intersecting the arrow. The delay is caused by farmers' inability to instantaneously adapt output to price. An adaption process may take up to a couple of seasons, as for example crop rotation needs to be adapted. The same structure can be found on the refinery level, but variable names change. The output is white sugar, and this is related to the amount of sugar beet provided on farm level. The more sugar produced, the higher the price for sugar beet and vice versa. These two feedback loops are connected, with the refinery sending a demand signal to farmers (see Figure 1b). B2 describes the connection; the higher the farm gate price, the less will be demanded, hence the less input will be used by the processor. The less input, the less output. The lower the output, the lower the demand, and thus, the lower the price. This will in turn increase the input purchased by the processor. This simple causal loop structure builds the basis for following causal loop diagrams, which expand on market structure variables, such as number of companies and scale effects.

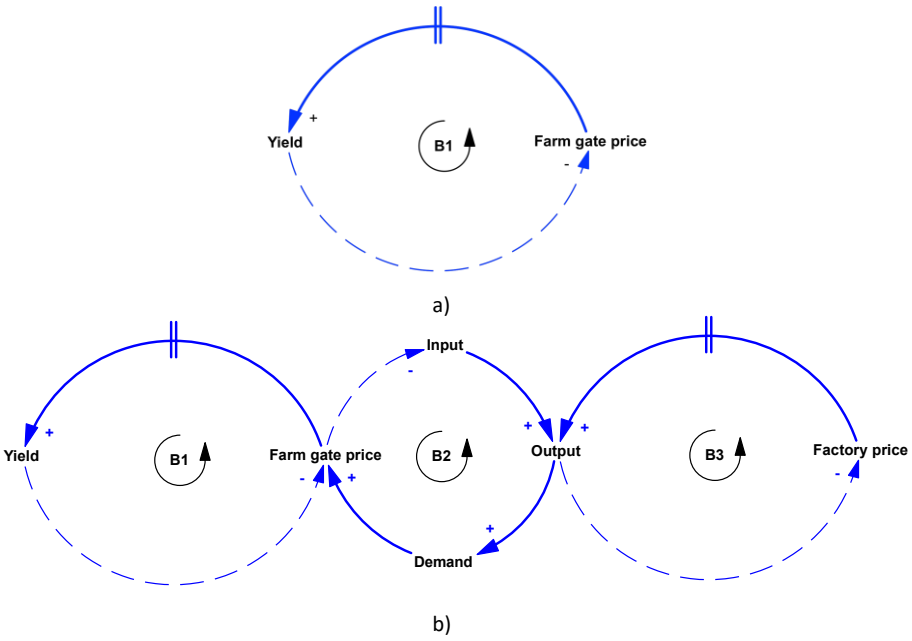

Figure 1. Simple causal relationship building the backbone of following causal loop diagrams. a) balancing feedback loop on farm level, b) balancing loop on farm and refinery level connected by a demand—supply loop.

4. Data collection

In order to gather the necessary information, we applied different qualitative research methods in a stepwise manner; literature research, semi-structured interviews, focus groups and a workshop. Interviewees, focus group as well as workshop participants had to sign an informed consent that guaranteed their anonymity and informed them about data storage, processing and use. Different data collection methods provide a wide variety of insights and are thus a means of triangulation. By stepwise employment of different data collection methods, an iterative process is followed which facilitates in-depth knowledge generation (Carter et al., 2014). Systems thinking calls for an iterative research process [12]. Hence, the data collection methodology was selected to support the analysis process.

The research process started with a desk-based investigation. Relevant literature, such as reports, media reports and scientific articles were screened to get an overview of the issue and identify important themes. These themes were the basis for the development of a semi-structured interview outline and were used to construct a conceptual map, which served the research team to get an overview of potentially important themes. Resulting from the desk-based research, identified themes were connected with each other in the conceptual map. Investigations were extended, wherever the research team could not pinpoint the relationship between themes. Upcoming questions were then answered by literature and by the following qualitative research steps.

The second research step consisted of nine interviews with Flemish sugar beet farmers in the summer of 2016. Another interview with a refinery representative was conducted in May 2017. Interviews were transcribed, translated and coded with the support of the NVIVO software,

following grounded theory [21]. Based on the results from the previous research step the conceptual map was further developed. Moreover, the first causal loop diagrams were developed. These causal loop diagrams display a subsystem, the value chain. Causal loop diagram, conceptual map and the codes in conjunction helped identifying blind spots. In order to fill these blind spots, three strategies were applied: consultation of relevant literature, further analysis of the interview transcripts, and development of a semi-structured focus group outline. The third research step consisted of two focus groups with 14 Flemish sugar beet farmers in February 2017. Both focus groups were recorded, transcribed and coded. Due to the exploratory nature of our research we applied open coding [21]. Codes developed from the interview transcripts were used for the focus group transcript as well, but new ones were developed if needed. The gathered information was then once more used to refine the causal loop diagram. Finally, in May 2017 a workshop was conducted with value chain representatives to verify or falsify as well as to refine the gathered results. The workshop data were collected via note keepers and output from the workshop, such as flipcharts and sticky notes.

Coding helped to synthesize the gathered information in the course of the research process. The relationships between codes were transferred into the causal loop diagram. This step is similar to axial coding [21], the result of which is a causal loop diagram, presented below. As Spicer [22] stated, model changes through the repeated process of model building. To understand causal relations, researchers need to identify the reasons for a situation unfolding in a certain way. Only the comprehension of the causes allows to (literally) draw connections and mechanisms can be understood [21]. Thus, the construction of causal loop diagrams is an iterative process of reexamining data. In order to illustrate this process, in section 5, we included statements of interviewed stakeholders.

5. Results

Our analysis focuses on the farm level, so we aimed at understanding the situation of the farmer within given circumstances. Moreover, a focal point was placed on the economic conditions and, within this realm, on market power issues. This choice was made due to the concentration within the sector, described in section 2.

The general information about market power allowed us to identify which market power causing themes are relevant for this case study. As the case study description indicates, concentration is an issue. Thus, the variables *number of actors* and *farmers' union* needed to be integrated in the causal loop diagram. The farmers' union is particularly important in the Belgian sugar beet case as all farmers need to be member of it. This means that the factory is not facing a larger number of farmers but one actor; the farmer's union. This, theoretically, equips farmers with more power in negotiations with buyers. Another relevant theme for market power identified at this stage was *substitution*. Sugar (sucrose) can be produced from sugar beet or from sugar cane. Apart from this, sugar (sucrose) can be substituted by other sweeteners. The availability of sweeteners does not translate in a complete substitutability, due to the characteristics of each sweetener [23]. Hence, each type of sweetener has its own demand, that influences the buyer's willingness to pay for the product. Along this line, substitution also affects the price elasticity of demand, a measure to show the responsiveness of the quantity demanded to a change in price. The lower the elasticity of demand, the higher the power of the seller in a non-perfect competitive market. For example, if a factory is solely able to process sugar beet, the demand for this good is relatively inelastic.

Based on the gathered information on the sugar beet case study, it is clear that the number of actors is pivotal, as there are only two refineries within Belgium. Also demand and supply elasticities, are important. In addition, through the process of analyzing the behavior of players within the chain we could identify additional key factors that influence market power. *Transportability* and *perishability* were identified as a missing link between the value chain structure and market power. The changing product characteristics at each stage of the value chain co-determine market power. At all stages of the value chain, actors are faced with certain demand and supply elasticities and a certain number of buyers and sellers, but transportability and perishability of the product determine the geographic scope of the market and hence the number of buyers and sellers as well as the supply elasticities. We will expand on this below. Another important factor are scale economies, which will also be explained in a following section.

The importance of the dynamics between price and cultivation decision became obvious by farmers referring to the milk quota problem. After the termination of the quota system in the milk sector in Europe in 2015, farmers overproduced, because of initially favorable prices. Later, due to overproduction, prices shrank and with this farmers' income [24]. Farmers in our case study described the fear of a similar process happening in the sugar sector. At the same time, some farmers pointed out that there is a difference between the milk and the sugar sector, which is why they think the quota termination would not lead to the same problem.

Erik[2]: So if that happens, if this system does not fail elsewhere and we do end up producing 25 percent more in Europe, then we'll end up with a similar scenario to that of milk, in the best of cases, that is. And that's a problem.

Lars: And if you start producing more, the price drops, as you can see with milk at the moment, leaving hardly any margin for the farmers.

Wout: Everyone compares the situation in the sugar sector with the abolition of the milk quota, which was and still is a real disaster. But there is of course a major difference between sugar beets and milk. For example on my farm, if we do not have a quota and we are free to do as we please and the crop is not profitable, we can immediately switch to another crop. Well, maybe not immediately, but we can search for a replacement. As for the milk quota, those farmers built sheds and invested heavily. They cannot escape, they have to continue.

The main difference between the situation of the dairy farmers and the one of the sugar beet farmers is asset fixity (see statement of Wout). The asset fixity explains why the feedback mechanism between output, price and demand did not work. As soon as investments have been undertaken by farmers, the relation between output and price is weakened by creating supply inelasticity. Shortly after the quota termination (season 2017/18) one can observe, sugar beet farmers similarly struggle with low prices due to overproduction of sugar beet [17]. Our analysis already foreshadowed this behavior. Though, when considering the simple causal loop diagram, it is not visible. Thus, in the following we will expand the causal loop diagram to illustrate the anticipated market behavior.

[2] To guarantee anonymity of interviewees names are replaced with publication names.

5.1. Transportability and perishability

As stated above, the number of buyers (processors) is not the sole cause for market failure in the sugar beet value chain. Suppose the number of buyers would be the only problem, then farmers could either store their crop until prices were better and/or search for alternative buyers in neighboring countries (Germany, France, the Netherlands). However, these strategies are unavailable to the sugar beet farmers due to *perishability* and *transportability* of the crop. Perishability implies the temporal urgency of the crop needing to be processed/consumed. This causes a certain degree of supply elasticity. Transportability indicates the costs for transportation. Both variables have been included in the causal loop diagram (see Figure 2).

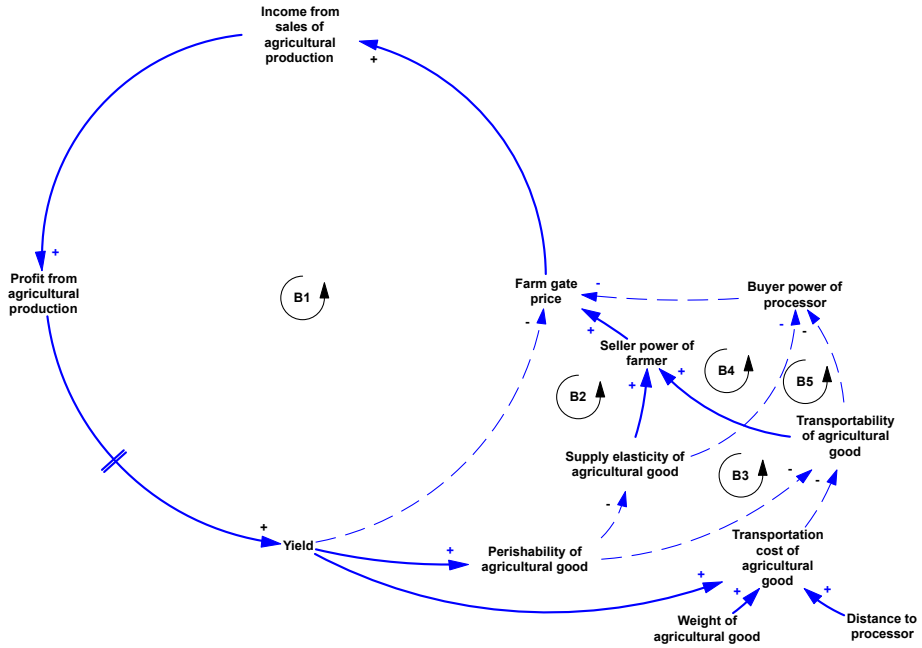

Figure 2. Farm level balancing feedback loop including the feedback loops that capture transportability and perishability.

Following Sexton et al. [25], perishability increases with the amount supplied in respect of stable demand. Further the perishability of a product determines the supply elasticity, which is low in the case of sugar beet. Thus, this increases farmers' pressure to sell their yield. Accordingly, their seller power is reduced with subsequent effects on prices (B2). The same can be formulated for the buyer side, whereat the effect is opposite (B4). Transportability is determined by the transportation costs, which are here limited to the factors *weight of the crop* and the *distance to the buyer*. The heavier and the more distant the buyer away, the higher the costs and thus the lower the transportability. Additionally, perishability also affects transportability, since a highly perishable good cannot be transported far (at least not without increasing costs, e.g., via air transportation). A

high transportability has a positive effect on the seller (B3) and a negative one on the buyer (B5). A seller's position is improved by higher transportability, as the number of potential buyers increases. The costs incurred by transportation are reflected in B7 in Figure 3 (next subsection).

Herman: The profitability is partly determined within a 100-km range. They look at how many beets there are, because otherwise the cost—the transport cost—risks getting too high.

Refinery representative: If you go to sugar, all sugar is dry, storable, can be transported all over the world. And this market, this world market has developed since more than 100 years. There are big volumes that are traded by if you want to sell sugar for a certain price because the world market price is good, you always have a buyer on the other hand.

Applied to the situation of sugar beet farmers in Belgium, it follows that the seller power of farmers is reduced compared to the power of the buyers. This effect is based on the product characteristic, which is low transportability and high perishability. Sugar beet needs to be processed quickly, as it constantly loses its valuable sugar content after harvest. Further, due to sugar beet being a heavy crop, it is uneconomical to transport it farther than needed. These two factors explain why sugar beet is not traded globally, but regionally. The only perfect substitute for sugar beet is sugar cane. However, similar to sugar beet, sugar cane needs to be refined quickly to preserve its sugar content [26]. Moreover, refineries in sugar cane cultivating areas have to be close to the field as well in order to minimize transportation costs [27]. In contrast raw sugar is traded globally, which is explained by the product characteristics. Figure 4 depicts the farm level linked with the refinery level. Loops having the same number are exact replica of the farm level loops. Although, the processing level would theoretically profit from low perishability and high transportability of raw sugar, seller power is mediated by another factor, the number of buyers.

5.2. Number of companies

Figures 3 to 5 represent the complete causal loop diagram of the farm and the refinery level. They are connected with B6, a balancing loop. This loop is in essence the same as B2 in Figure 1, but with more detail. The higher the farm gate price, the higher will be the input costs and thus the total costs. The higher the costs, the lower the profit. The less profit, the less output and thus demand for output, which in turn affects the farm gate price. Figure 3 highlights (in red) the effect of the number of farmers and processors on market power. One factor determining the number of farmers and processors, is the profits made by actors at each segment of the value chain. The higher the profits the higher the incentive for new players entering the market. The more processors, the lower will their buyer power be (B9) and the higher will the seller power of farmers be (B8). Moreover, the more processors there are, the lower will be their seller power (B10a), but the higher will be the buyer power of manufacturers. Note that this would change in the presence of some kind of legal or illegal cooperation among processors. This concept once more covers basic economic considerations [9].

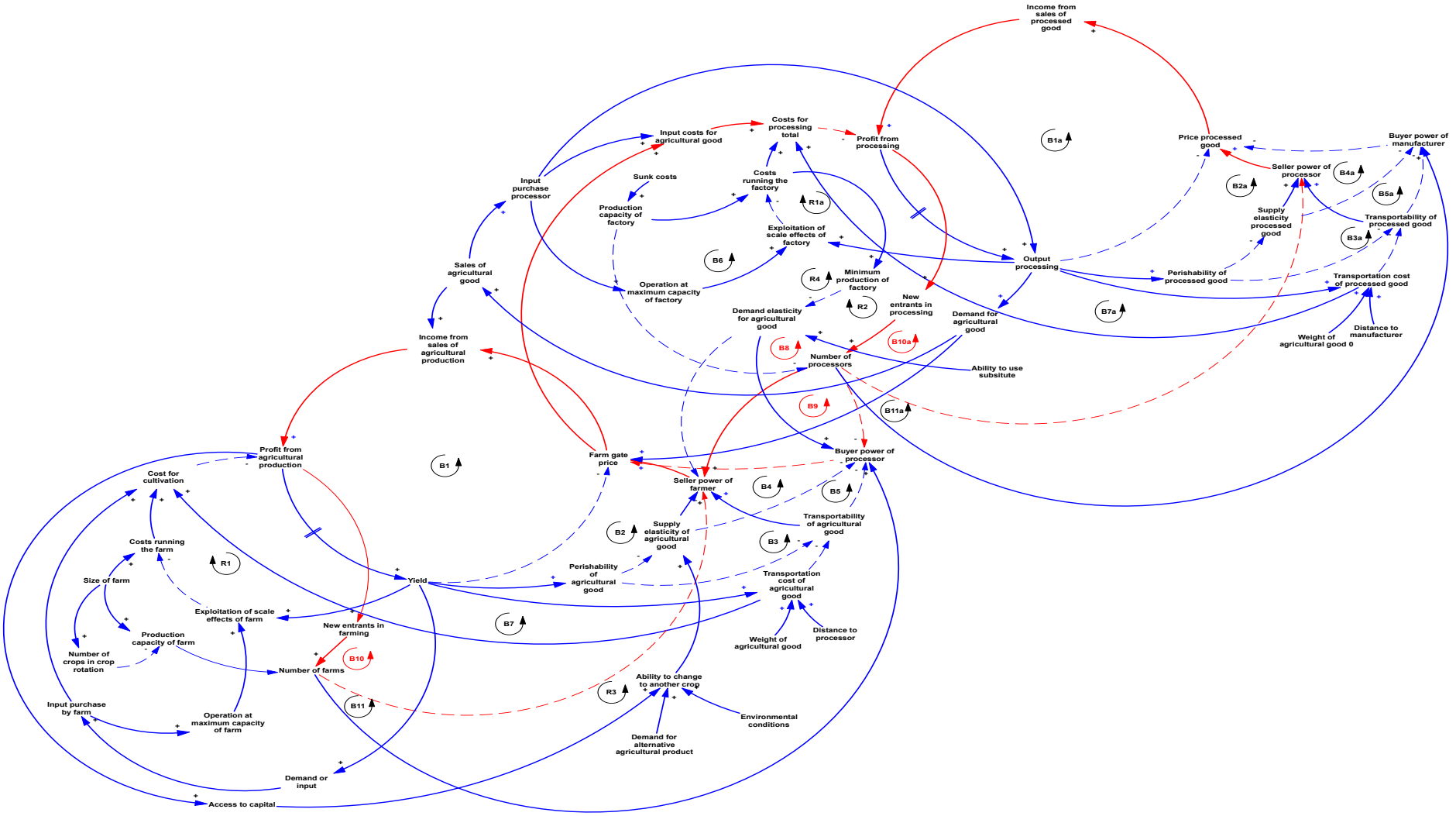

Figure 3. Number of companies: feedback loops within the value chain causal loop diagram.

Profits should only be higher than marginal costs at the presence of some degree of market power. In the absence of entry barriers, new players would enter to absorb these profits. Setting up a sugar refinery is a costly endeavor (*sunk cost* in causal loop diagram) and thus forms an entry barrier. This fact explains why there are only two refineries in Belgium.

5.3. Scale effects

Entry barriers are not only affecting the number of players in the market, but they also explain another factor that needs to be included in the causal loop diagram: scale effects. The outlined causal relations do not explain why processors intend to increase their output. We have so far established that Belgian sugar processors have buyer power due to the characteristics of the crop and the number of refineries in close proximity to farmers. According to economic theory processors should have no interest in increasing output, since this would reduce their profit. Still, this was their intention when the quota period terminated.

Teun: We're always expected to produce more and more—it's the same for milk.

Stijn: Why I phoned asking to join? Well, for the same reasons as Laurent's but mainly because I feel like this is a crucial and dangerous moment for sugar beets, especially because the industry wants us to produce 20% more. In reality, that's what they're asking, right?

Jan: De Suikerraffinaderij is a good company, but they aim for a longer production period to reduce their fixed costs.

As profit maximizing corporations, processors would want to further increase their profit. Competing on the global market for sugar, they can only harvest additional profits, by providing high quality sugar at a competitive price. Clearly, reducing the input price is one strategy to achieve this goal. Increasing production, would however, rather increase costs and thus profits would not increase, unless scale effects can be engaged.

Refinery representative: Of course, but our business is risky as well. If the yield is low, like last year, they have a lower yield per hectare, but we also have less sugar and we have our fixed costs which stay there. Our variable costs might be low, but the fixed costs they are there. There is no discussion about it. And this is really the big trigger in the sugar sector that we have to try to manage this risk of the fixed cost. That is also why we want to increase our production, to reduce our fixed cost per ton produced.

Johan: As for upscaling, we have a few very clear scale effects that will manifest themselves in the upcoming decade. Our farmers are, on average, 56 years old, all of them. A colleague who now has 10 or 20 hectares can take over and boost his beet production up to 20 or 30 hectares. Financially speaking, you're better off with 10 or 15 than with 5. You need the same amount of pesticides and your day-to-day activities and operations, I can see a difference there from a business and economic perspective. So we're evolving toward larger-sized farms.

Scale effects (R1) cause the formation of a reinforcing loop which explains why a processor would want to increase production. The scale effects are shown in Figure 4 (colored in red). The more scale effects are exploited the lower the fixed costs of the factory. A strategy that has been employed all over Europe after the quota termination [17]. The lower the fixed costs, the lower the total costs, and the lower the total costs, the higher the profit. Eventually, the exploitation of scale effects will be zero (when optimum capacity of the factory is reached). If exploitation of scale effects becomes zero, there will no longer be a reduction of fixed costs and thus this will no longer be an

incentive for increased production (hence a balancing loop will kick in). The larger the exploitation of scale effects, the larger is the incentive to increase production. A similar pattern could be applied for the farm level, where farmers who were so far not able to increase production due to the quota regulation, strive to increase production in the post quota period. Scale effects are triggered by the size of the plant, which are also related to sunk costs. Not only does the dimension of one factory determine the potential scale effects, it also acts as an entry barrier in three ways. First, high investment costs may deter potential newcomers. Second, the ability of existing processors to instantaneously step up production if threatened by new entrants, functions as an entry barrier. Third, the larger the processors' factories, the less factories will be needed to cover the demand [9].

5.4. Demand and supply elasticity

The relevant loops for demand and supply elasticity are emphasized in Figure 5 (colored in red). Demand and supply elasticities explain why farmers are not simply switching to another crop, when faced with crumbling prices. Although it was pointed out that the investments in sugar beet farming are much lower compared to animal husbandry, asset fixity is still relevant [for an explnation of asset fixity see: 9]. Belgian sugar beet farmers hold shares of the refineries (SOPABE or SPABE-T), which must be sold if sugar beet cultivation is discontinued. Further a replacement for the income from sugar beet needs to be found. A task that is coupled with some obstacles. Environmental, economic as well as legal factors need to be considered. Stated differently, a crop that fits within the rotation cycle, the climate and soil conditions, for which a market better than the sugar beet market exists needs to be found. Other crops may further require the farmer to undertake new investments (e.g., storage, machinery, knowledge). These factors influence the supply elasticity, which also affect the seller power of farmers. The supply elasticity has already been discussed, whereat it was limited to perishability (B2) and the delay within loop B1. Though, one could further distinguish between short term and long-term supply elasticities. The farmers' ability to change to another crop determines the long-term supply elasticity and with this their seller power (R3). Elasticities are also a factor on the refinery level. The production capacity and related costs influence the minimum production of the factory and hence the demand elasticity for sugar beet. The higher the minimum production and the more restricted the supply, the higher will be the selling power of farmers and the lower the buying power of refineries (R4). Similar to the farm level the long-term demand elasticity of the processor depends on whether or not it is possible to use substitutes. Which is not the case on refinery level. An interesting result of this analysis is the identification of R3 and R4. The ability to adapt the cultivation in the long run, is a key factor improving the position of farmers. Thus, in order to empower farmers' position within the value chain, their ability to adapt should be supported. R4 indicates that large production facilities counteract a favorable position of processors, as it reduces their demand elasticity. This is a fact very well known by the farmers. The overproduction after the quota termination indicates that farmers have not yet exploited the R4 to their favor.

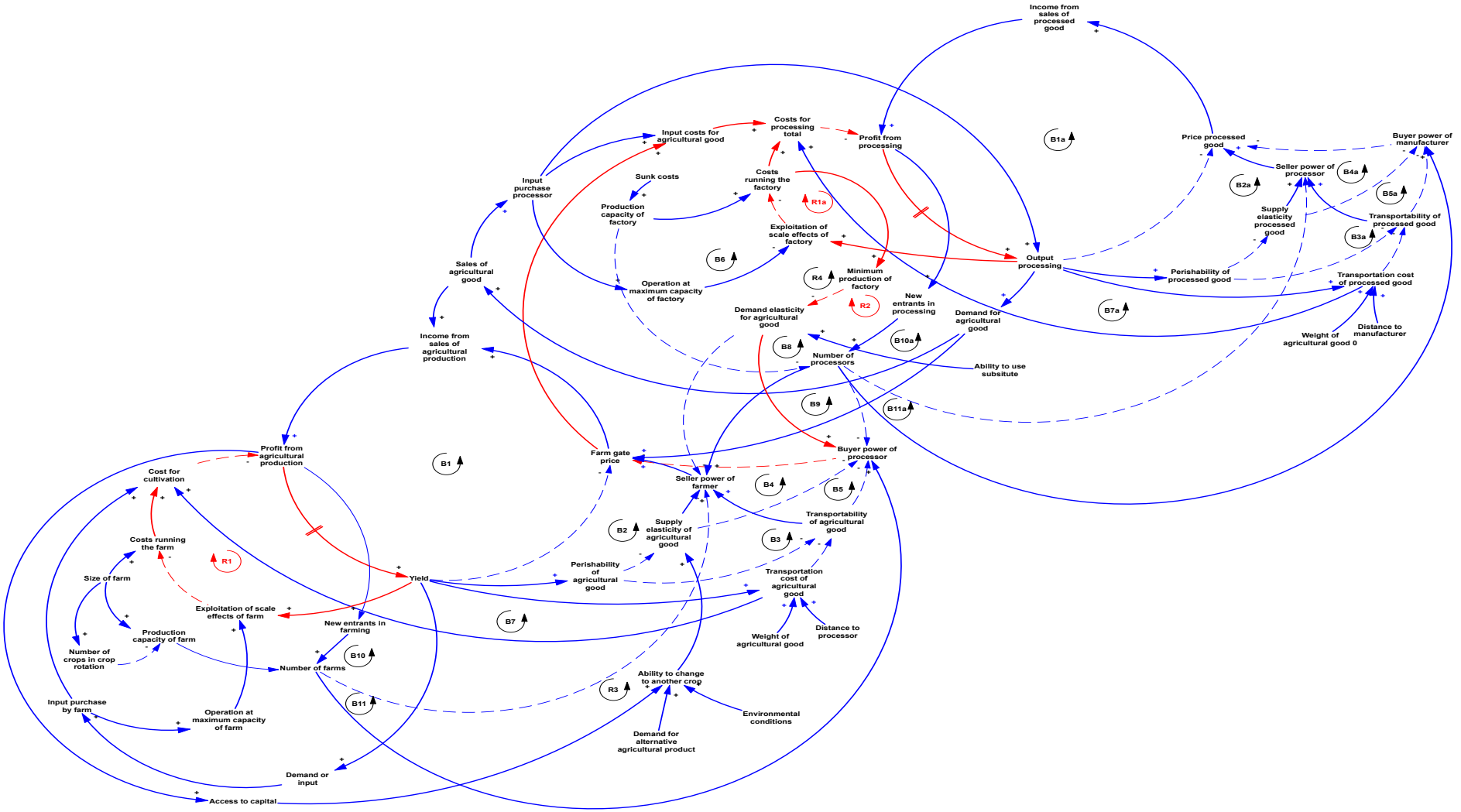

Figure 4. Scale effects loops: feedback loops within the value chain causal loop diagram.

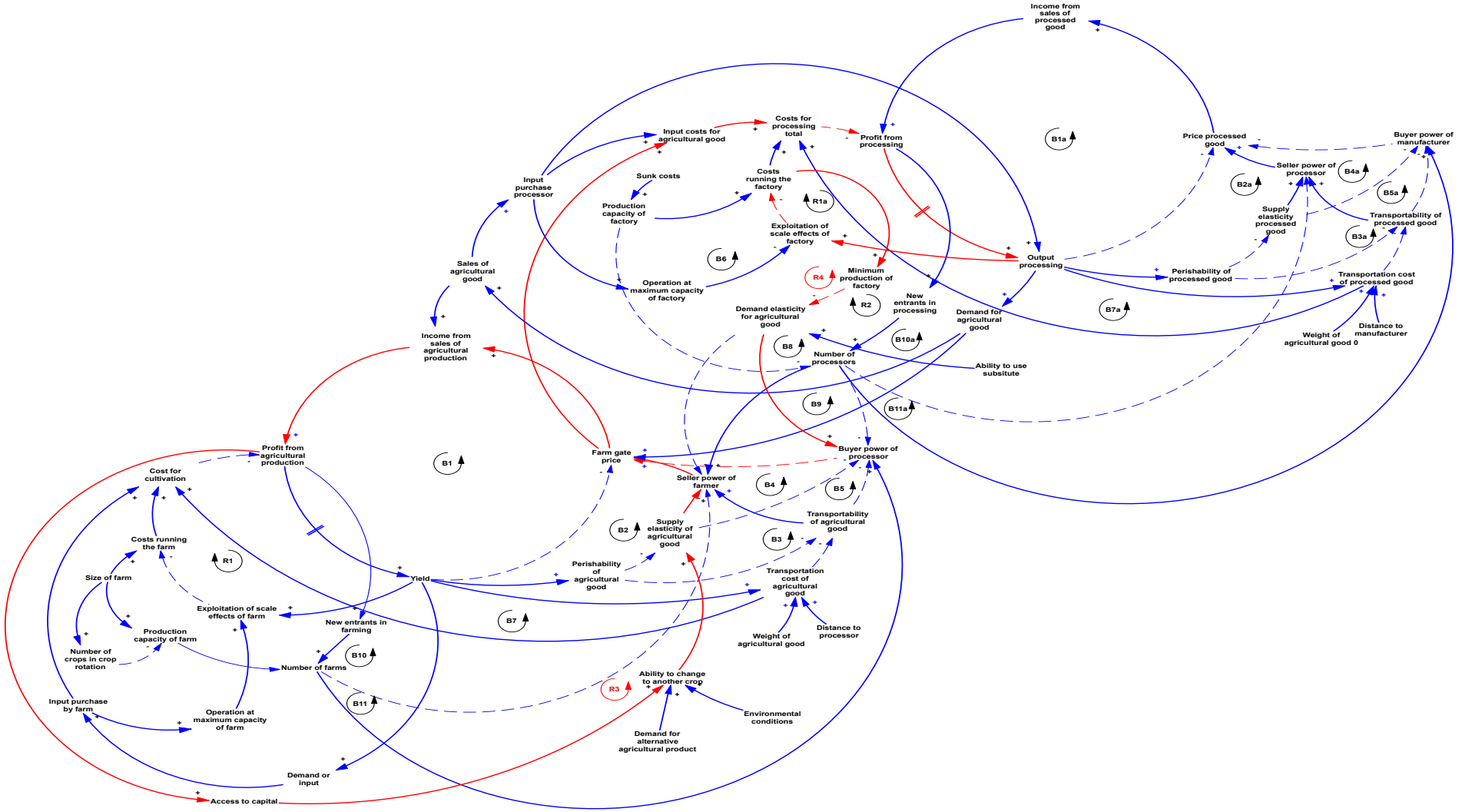

Figure 5. Demand and supply elasticity: feedback loops within the value chain causal loop diagram.

6. Discussion

During one focus group, it was emphasized that an important strategy in the post quota period is the stabilization of sugar beet cultivation in order to maintain the price level. The causal loop diagram explains the reasoning for this strategy. Supply is the only leverage farmers have at this point (B1). The factory needs more sugar beet to increase profitability (R1). If farmers increased their production, they would worsen their situation (because of the reduced farm gate price), while improving the situation of the refinery (by reducing their unit costs). Interestingly understanding the effects of increased productions did not prevent overproduction to happen. Hence, while systems thinking can help understand why the current situation led to overproduction, it cannot explain seemingly irrational behavior of stakeholders. Research on bounded rationality may deliver insights pertaining this issue [28,29]. It is beyond the aim of this paper to expand on problems of bounded rationality. However, it is necessary to point out that the understanding of a particular circumstance may still not be enough to act *rationally*. Having said that, it is not to downgrade the usefulness of systems thinking. Rather it is the call to include more perspectives.

In the course of data collection opposing views, pertaining the need to reduce sugar beet prices, came to the surface. Farmers were partially not understanding why the Belgian market is dictated by the world market. On refinery level, on the other hand, it is not understood, why farmers do not apprehend that refineries are forced to obey the world market. The subsection on perishability and transportability gives some indication for the reason of this misunderstanding. Changing product characteristics determine the geographic scope of the market at each level of the value chain. Liberal markets render impossible the ability of market agents to shield from global market impacts. While farmers are naturally shielded due to product characteristics, this is not the case on refinery level. In order to remain competitive, market agents need to produce at lower costs. If sugar refineries would not reduce their prices, they might lose globally active customers. This would result in lower demand for Belgian sugar beet and hence in lower prices for the crop. Accordingly, buyer power of manufacturers who can chose the best offer on the global market is transmitted upstream the value chain. Therefore, farmers who want to continue cultivating sugar beet have two choices. Cultivating less at a lower price, or cultivating more at a lower price. If farmers are able to exploit scale effects they will go for the second option.

We do not intend to focus on policy interventions in this analysis. However, due to the situation of the Belgian sugar market, it is necessary to briefly address the main ones relevant to the case and market power. Although the quota regulation has terminated, the market is not completely liberalized. Sugar imports are still limited. This of course affects competition on processing as well as manufacturing level. Further, our causal loop diagram indicates that the higher the number of actors the lower their market power. Cooperation among market actors is usually forbidden by antitrust legislation. Though, farmers are allowed to cooperate and form producer organizations. This means that the number of farmers does not reduce their market power. Rather the contrary is the case. The power of a producer organization, can be determined by the number of farmers within the organization as well as the proportion of farmers being and not being member of the organization. All Belgian sugar beet farmers are part of the farmers' union CBB. This equips them with the highest possible degree of power, with each farmer leaving the union decreasing it[3]. The power of this union

[3] A potential problem that was pointed out by farmers several times during data collection.

can also be evaluated in the light of a new cooperative sugar refinery that is about to being built in Belgium [30]. This constitutes a new strategy that was brought up by a farmer during the second focus group. At that time, it was a mere hypothetical discussion. Though the capital intense *castle in the air* is becoming real. As we have pointed out, high investment costs for setting up a sugar refinery constitute an entrance barrier. Finances necessary for the investment are mainly covered by the farmers (equity and credit). Already joint forces of sugar beet farmers, allowed them to quickly react to worsening conditions on the sugar market. Moreover, the plans for a new refinery will also receive (financial) support by the regional government [30]. Such policy interventions affect the power balance within a market. Though, they may be necessary due to the oligopsolisitc[4] situation on the processing level on Belgian sugar beet market. These new developments indicate that Belgian sugar beet farmers intend to create a new market situation, that may offer a third option; producing more for a higher price. A new situation which may cause R4 to take over to the detrimental of the existing Belgian refineries. In essence, one of the existing refineries may be forced to close down if not enough sugar beet supply is secured.

7. Conclusions

The analysis has shown that causal loop diagrams can be a powerful tool to help understanding a complex situation. We could illustrate that market power is not simply a factor of the number of players at each level of the supply chain, as already pointed out by Mason [18]. Thus, the structure of the market is not merely defined by the size or the number of actors. Rather we could identify, similar to Mason [18], that product characteristics as well as supply and demand elasticities need to be included. Systems thinking, allows to include a wide range of factors and to jointly analyze their effect within the system. Further, systems thinking does share the notion that the structure of the system evokes a particular behavior and thus performance. Moreover, the distinction between intrinsic structural variables and derived structural variables[5] [31] turns out to be pivotal for the analysis presented in this paper.

The structure of the causal loop diagram explains the behavior of different chain participants. Causal loop diagrams are not only an interesting tool to understand the behavior by the structure, but also to understand how structures may change because of behavior. Regarding our sugar beet case, the new cooperative refinery constitutes such a structural change. The market structure determining factor *number of companies* changes, which may in turn affect conduct and performance of the companies within the market. The structural change that is about to happen, was triggered by conduct and performance of the companies currently in place. Hence, systems thinking is not limited to linear thinking, but employs circular thinking resolving the problem of endogeneity.

The causal loop diagram allows to investigate market power issues, in a situation of lacking data. While the lack of data is a common problem for market power estimations, the sugar beet case also suffers from (policy) distortions that make market power estimations even more difficult. Thus, traditional market power estimations would need price data in the post quota period over a long time

[4] Oligopsoly is a situation with two buyers on the market who have buyer power.

[5] (a) Intrinsic structural variables—those determined by the nature of products and available production and marketing technologies. (b) Derived structural variables—those determined by firms and government such as barriers of entry, seller and buyer concentration and product differentiation [31]. Lee C, *SCP, NEIO and Beyond*, in *Working Paper Series Vol. 2007-05*, U.o. Nottingham, 2007.

period. Estimations that reveal market power issues can then come too late for policy makers to design appropriate policy instruments. Hence, systems thinking is a useful tool to assess a situation ex ante and to support policy making. An understanding of the market structure and the underlying factors constructing this structure, may help policymakers to tackle the root cause of a problem instead of treating a symptom. Though, it has to be pointed out that the development of causal loop diagrams is an intense process depending on detailed data.

Market power issues may not be caused by the ill will of economic agents, but by factors that bring into life a market structure prone to market power issues. Factors such as product characteristics or the need for scale economies, need to be considered when counteracting market power problems along the value chain. The sugar beet example shows that the sugar beet crop inherently involves dependencies. Accordingly, policies may be needed to protect farmers from these dependencies. Similarly, other factors such as the need for scale economies and the resulting increased risk for bankruptcy due to high fixed costs, may call for the attention of policy makers. Wherever markets are confronted with issues of dependencies and high risk, counteracting policies could be considered, as these markets may not fulfill the requirements to function perfectly competitive.

This paper constitutes an attempt to access the SCP paradigm via the tool of systems thinking as suggested by Grether [13], drawing from value chain research performed by Gereffi, Humphrey [6] and Cox, Sanderson [7]. Further research could compare different markets to investigate if they have distinct structures that then cause market specific behavioral patterns, as proposed by Mason [18]. Another future research avenue could be the extension of the causal loop diagram, by applying system dynamics. This would allow building scenarios, that could be used to inform policy makers.

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Conflict of interest

The authors declare no conflict of interest.

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