Power imbalances in the Belgian sugar beet market: employing systems thinking for a supply chain analysis

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Abstract: *According to the theory of Industrial Organization market power is determined by the structure of the market. From a particular structure, market agents' conduct and performance can be inferred. This relationship is called the Structure-Conduct-Performance (SCP) paradigm. However, due to certain shortcomings, this paradigm is dismissed and substituted by the approach of the New Industrial Organization (NEIO). While the amendments of NEIO are valuable, this paper expands on the importance of structure for the occurrence of market power issues. Systems thinking emphasizes the relevance of structure for the conduct of the whole system and the agents within the system. Thus, systems thinking can be a valuable tool to understand the emergence of market power. With the example of the sugar beet case we demonstrate how systems thinking can support the identification of market power issues. The advantage of systems thinking is that it can be applied as ex-ante tool to policy changes. Moreover, market power may not be measurable in the sugar beet case due to price regulations during the quota system, systems thinking can identify market structures that have the potential to give rise to market power issues. Additionally, systems thinking is a potent means to understand complex matters by holistically taking into account a wide range of variables. In consequence systems thinking can serve as tool to inform policy makers.*

Keywords: *systems thinking, causal loop diagrams, market power, supply chain, agrifood chain, sugar beet*

Introduction

The Structure-Conduct-Performance (SCP) paradigm within the body Industrial Organization (IO) was until the 1970ies the leading concept to analyze market power issues. The SCP paradigm assumes a causal relation between the structure of the market, the behavior of firms and their performance. Whereat, the structure refers to the number and size of the market as well as to factors that influence the number and size of these firms (Martin 2012). Moreover, the SCP paradigm postulates a relationship between market concertation and market power (Cabral 2000). Critiques of the SCP paradigm pointed out the endogeneity problem of structure and conduct (Lee 2007; Slade 2004). Due to the criticism other methods have been developed to assess market power (Slade 2004). One for example is the New Empirical Industrial Organization (NEIO) framework, which focuses on conduct, rather than structure (Cabral 2000; Lopez et al. 2017). However, some may point out that conduct still depends on structure (Brown 2002) and that although structure may suffer from the problem of endogeneity, structure often cannot be changed in the short term and can thus be taken as a stable factor (Martin 2012). While there has been criticism about the validity of the SCP paradigm, there is also evidence for the correctness of the assumptions underlying the SCP paradigm (Martin 2012). Additionally, other theoretical frameworks, such as NEIO, are

neither free of shortcomings (Perloff and Shen 2012). In any case, no theoretical framework is perfect, thus, the best of them should be taken from them and possibly combined with others. Brown (2002: 105) states that the SCP paradigm should not be understood as "a straightjacket, but rather a tool for organizing the scientific study of particular problems". Accordingly Borenstein (2016) calls, not for a deepening, but for a broadening of methods.

While the SCP paradigm struggles with the feedback between structure and conduct, system thinking embraces feedback mechanisms. Moreover, systems thinking supports the understanding of dynamic behavior (Sterman 2000). Brown (2002), emphasizes that NEIO models are based on the assumption of the existence of a state of optimality and results are benchmarked against this optimal state. This fact is also pointed out by Blaug (2001), who expands on the problem of the idea of a final optimal state that is aspired by competition. Blaug (2001) elaborates that there is no perfect competition and hence no optimal final stage of market interaction. If there is no benchmark, econometric exercises to evaluate a certain situation are pointless. From this he concludes that "[…] we must engage instead in qualitative judgements about piecemeal improvements, embracing a dynamic process-conception of competition […]" (Blaug 2001: 40). Apart from this, NEIO models often face the problem of lacking data (Cabral 2000: 160). Systems thinking can use both quantitative and qualitative data. Qualitative data helps identifying structures, important variables and the boundary of the system. Quantitative data allows to calibrate the model. Though, the fit of the model can finally only be checked by logic considerations based on human sense and information gathered to build the causal loop diagram / stock and flow model. While we do not intend to downplay the valuable contribution by IO or NEIO models, we suggest that systems thinking can be a potent tool to examine market power and solve the problems of SCP and NEIO models. Therefore, 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 a sugar beet case study in Belgium. Although we are not applying system dynamics, we will show how using causal loop diagrams can help understanding the dynamic mechanisms of a market.

In order to outline the usefulness of systems thinking for the analysis of market power, we will first introduce the case study. In the following section the method employed will be outlined. Thereafter, the analysis of the case study will be presented. Finally, results are briefly discussed and a future research avenue indicated.

Case study introduction: sugar beet production in Belgium

Belgium is the fifth largest sugar beet producer in the EU with total harvested sugar beet area of about 60,000 hectares in the 2014/2015-crop season. This represents about 4.5% of the agricultural area in Belgium. In Belgium, the total sugar production from sugar beet is about 646,000 tons (CBB 2017b). There are about 7500 sugar beet farmers in Belgium spread across the 14 agro-ecological zones (CEFS 2015; Peeters 2010). Between 1968 and 2015 the number of sugar beet farmers reduced from 36114 to 7513. Alone since 2006, 6184 sugar beet farmers have been terminating their operations. The number of sugar beet growers has been declining steadily over the last decade with a sharp decline occurring between 2007 and 2008. The concentration on the refinery level is even more pronounced. 174 sugar beet factories could be found in Belgium by 1872 (CBB 2017b). Today only three refineries remained in Belgium, which are owned by two companies; Iscal Sugar and Raffinerie Tirlemontoise / Tiense Suikerrafinaderij (CBB 2017b).

Since 1967 sugar production is regulated within EEC, later by the EU and hence also within Belgium. Apart from international regulations by the World Trade Organization (WTO) and the Generalized Agreement on Tariffs and Trade (GATT), there is a series of European regulations for the sugar sector. In the beginning, the European regulations aimed at protecting the national sugar market and sugar supply. However, over time these regulations loosened and the sugar market was gradually liberalized. The most important regulations since 1967 have been regulation (EEC) No 741/75 of the Council of 18 March 1975 laying down special rules for the purchase of sugar beet, this was repealed by (EC) No 1260/2001

in 2001, which was repealed by (EC) No 318/2006 in 2006, which was repealed by (EC) No 1234/2007 in 2008, repealed by (EU) No 1308/2013 in 2013, which is still valid. The regulations established a Common Market Organization (CMO) for sugar which was later (in 2013) transformed into a Common Market Organization (CMO) for agricultural products. Until 2006 a main feature of the sugar market was the establishment of the quota system. Among EEC/EU countries quotas were distributed among refineries, which then were distributed among farmers. Quota could be distinguished in “A”, “B” and “C” quota, whereat the latter was sugar that was sold at world market price. For the other quota types a minimum price well-above the world market price was determined. The reform of 2006 lead to a significant reduction of quota and the minimum price, preparing farmers for the transition to market liberalization. Moreover, these measures should increase the competitiveness of the domestic sugar market. Another special feature of the EEC/EC regulations is that they require refineries to negotiate delivery conditions (and now also prices) with the farmers’ union. Thus, refineries shall not negotiate with farmers individually. This is a mechanism that particularly now, with the termination of the quota system, promotes the creation of an equal level playing field in this highly concentrated market.

The reform in 2006 led to a reduction of quota, which also means that the number of farms cultivating sugar beet needed to be reduced. At the same time farm size increased continuously. While the number of refineries decreased drastically since 1968, the sugar production illustrates an increasing trend. Though it has to be pointed out that since the reform of 2006, the trend is rather decreasing. Since refineries intend to increase their production in the post-quota period, production levels may increase again. Despite the decreasing number of sugar beet farms and sugar beet cultivation area, the sugar beet yield remained rather stable. For the plantation year 2017/18 the overall sugar beet sowing increased (CBB 2017b). This is possible, due to the termination of the quota system. This means that there are no restrictions on sugar beet cultivation anymore. It is open to speculation which effect this is going to have. Overproduction may lead to a price drop which may make the cultivation of sugar beet unprofitable.

Within Belgium, sugar beet farmers have only one sales channel, via the Confederatie van de Belgische Bietenplanters (CBB), which is a Producer Organization that was installed in 1965. According to the CBB, its goal is to represent and defend the interests of Belgian sugar beet farmers at local, regional and national level (CBB 2017a). 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 inspectors from CBB are permanently present in order to monitor the work of the personnel of the sugar refinery and test whether all reception conditions are fulfilled. They moreover control the pulp and report their results to the farmers (CBB 2017b).

Sugar beet marketing is regulated by interprofessional agreements concluded between refinery and farmers’ union (CBB). As pointed out above, the minimum price was set by the European Commission. While a premium was paid in years with higher world market prices, the price could not fall below this minimum price. Also, farmers were certain that their produce was purchased by a refinery. However, since 2006 the minimum price reduced and with the termination of the quota system in September 2017 prices may fall even further. In the marketing year 2016/17 the two refineries Iscal Sugar and Tirlemontoise / Tiense Suikerrafinaderij had different approaches. While Iscal Sugar maintained their past price strategy, the price that Tirlemontoise / Tiense Suikerrafinaderij payed reduced. It remains to be seen in the coming years how prices will develop and whether Iscal Sugar will be forced to reduce their price as well.

The method

The system thinking exploration is studied by the development of causal loop diagrams. Banson et al. (2016) used a causal loop diagram to describe the structure, conduct and performance of the Ghanaian agricultural sector. While their paper exemplifies the usefulness of systems thinking for the analysis of the SCP paradigm, we used systems

thinking in different manner. First Banson et al. (2016) distinguished within the causal loop diagram between structure, conduct and performance variables. They state that structure includes variables that are relatively stable and affect the behavior of the actors under investigation. Conduct variables are about the behavior of farmers, and performance variables are understood as efficiency and profitability of the activities. We disagree with this distinction. The first reason is that in systems thinking, the structure is the connection among and between all variables; the skeleton so to say. The behavior, or the conduct, can be observed as a result of the structure. Thus, conduct can be observed in all variables. All variables react to some sort of continuation or change of other variables within the system. The performance is the evaluation of the resulting conduct against certain benchmarks[1]. One reason for the different understanding of the role of variables might be that Banson et al. (2016) did not use a stock and flow diagram (at least not in their publication). We do believe that it is not necessary to convert a causal loop diagram into a stock and flow diagram, however practitioners should be aware that there is a difference between stocks and parameters which influence the flow, thus accumulation, depletion or stabilization of stocks and thus the performance of the system. The difference between stocks and parameters is not made explicit in causal loop diagrams. Stocks are affected by the parameters. They determine in concert with the overall structure behavior of the stocks (depletion, accumulation, stabilization). Hence, one could think, that parameters are structure and stocks are conduct or performance variables.

Secondly, we explicitly look at market power, while Banson et al. (2016) did so implicitly. They tested how certain variables react if perfect competition was introduced. This differs to our approach, where we used a causal loop diagram to understand the presence, consolidation or emergence of market power. The assumption was, that by understanding the structure of the system, we would understand the behavior of it.

The usefulness of systems thinking for the analysis of the agrifood supply chain is illustrated by the Gereffi et al. (2005). They point out the importance of structure in their work and link it to competition and value creation along the supply chain. Gereffi et al. (2005: 312) 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 agrifood system under investigation."

In order to analyze the case study, we followed three main steps regarding the development of a causal loop diagram. First, the relevant variables necessary to describe and understand the system of the case studies under investigation were identified and arranged in a general systems map that contained, social, ecological and economic variables (see Figure 1). The purpose of this general systems map is getting an overview of potentially important factors. This general systems map was narrowed down to the supply chain. Finally, we further specified and focused on the links between farmers and manufacturing with a specific focus on market power.

The data collection followed the project's guidelines and were based on qualitative research methods. These where applied stepwise and used as means of triangulation. Desk based research was followed by nine interviews with sugar beet farmers in 2016, succeeded by two focus groups with Belgian sugar beet farmers and finally finished by a workshop with stakeholders of the whole supply chain in 2017. The data of interviews and focus groups was audio recorded, transcribed, translated and fed into the NVIVO software, where it was analyzed following grounded theory (Strauss and Corbin 1998). The workshop data was collected via note keepers and output from the workshop, such as flipcharts and sticky notes. Within the process of gathering information the causal loop diagram was refined and narrowed down. The causal loops diagrams helped the research team to structure information and to identify knowledge gaps. Due to the richness of the collected data,

[1] Benchmark is here not understood as reaching a state of equilibrium as understood in microeconomics, but rather as a state that is desired by certain stakeholders.

upcoming questions could be answered by re-consulting the database. Information about market power was extracted from the above mentioned data sources, but also from literature, like economics textbooks (for example:Cabral 2000; Lee 2007; Lipsey and Chrystal 2015).

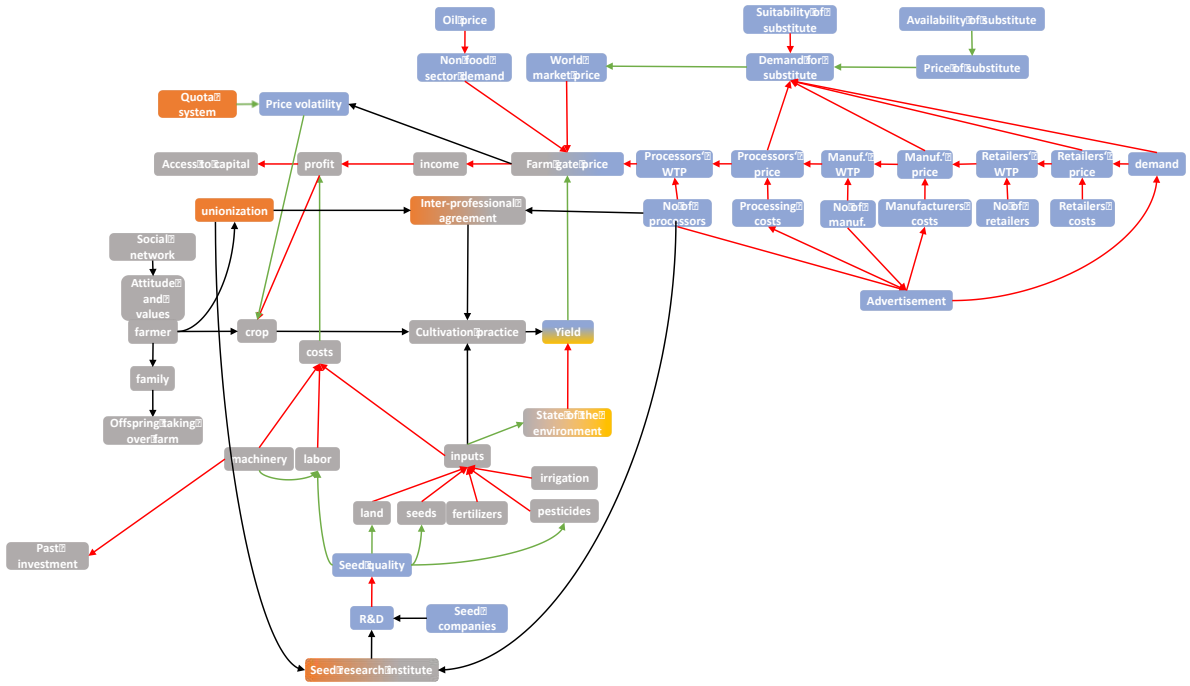

Figure 1. General systems map. Different colors of boxes are used to visualize different parts of the system. Blue indicates market variables, grey stands for farm level, orange represents policy and yellow depicts environmental variables. The connections are colored in order to demonstrate the effect of the connection. Red arrows indicate that the receiving end moves in the same direction as the start, green arrows mean that the receiving end moves in the opposite direction as the start. In systems thinking often the mathematical operators +, - or the letters S and O are used to indicate the effect of the arrows. Since colors are easier to grasp in a large diagram, we made use of colors instead. Arrows are black if the effects are not clear at this level of the system, thus the variable is too broad and needs further refinement. Another reason for black arrows is that variables are rather parameters, hence a characteristic of a certain variable. The direction of the arrow gives information about the direction of the causal relation.

For the generation of the causal loop diagrams we simply use power point slides. The main reason for this is that the visualization options within power point suited our needs. We heavily draw on colors, that help to cluster variables and interpret the direction of the linkages between them. We also believe that such graphs are more accessible to stakeholders, fostering discussion. Apart from this, we also used white boards. The advantages of white boards are that they allow the researcher to look at the causal loop diagram from a distance. A computer screen quickly becomes too small to facilitate analysis. From a practical standpoint, white boards also allow a quick and easy rearrangement of variables and connections. This method could also be used to support the thought process with stakeholders.

The analysis

To study the interrelationship between the value chain structure and market power, the general systems map was refined towards a supply chain causal loop diagram by zooming in on the value chain part (see Figure 2).

In the supply chain causal loop diagram, each step of the supply chain is described. The aspects that where identified in the general systems map are still in place, but complemented with new ones. Based on the gathered information on the sugar beet case study, it is clear that the number of actors is pivotal, with only two refineries within Belgium. Indeed, also demand and supply, hence elasticities, are important. In addition, transportability and

perishability were identified as a missing link between the supply chain structure and market power. The changing product characteristics at each stage of the supply chain co-determine market power. At all stages of the supply 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 magnitude of the market and hence the number of buyers and sellers as well as the intermediate elasticities.

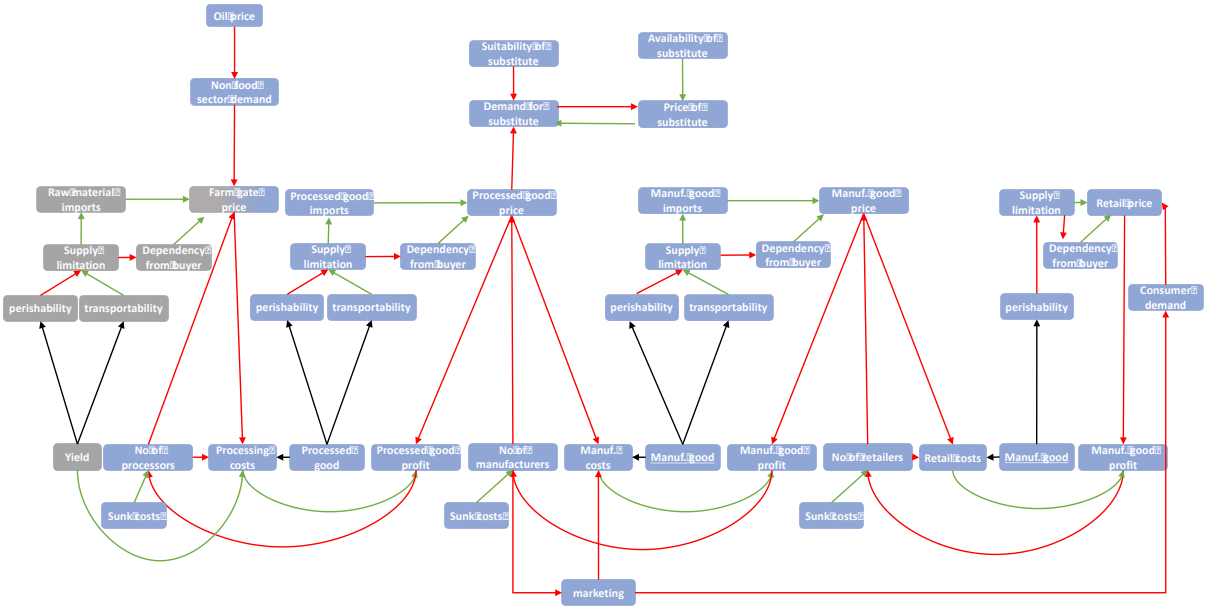

Figure 2: Supply chain causal loop diagram

By focusing on smaller segments of the supply chain, the above-mentioned variables that determine market power are easier to identify. Since our main interest is the farm level, in the following, the supply chain segment between the farmer and the refinery is further discussed. At the core of the causal loop diagram, at each level of the supply chain, is the relationship between the commodity and the price received for it (see Figure 3). 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 remains the same. In turn, the price feeds back into the yield, since the price will determine how much the farmer will sow. Usually, the higher the price, the more will be sown. This relationship builds a balancing feedback loop. Because there is a delay between yield and price signal, a fluctuating pattern of yield and price will be observable (see Figure 5). The same structure can be found on the refinery level, but certain variables change. The output is not sugar beet, but white sugar, and this is related to the amount of sugar beet produced at farm level. The more sugar produced, the higher the price for sugar beet and vice versa. Because of two balancing feedback loops that both have delays operating in succession (see Figure 4), the fluctuations will be elevated (see Figure 5).

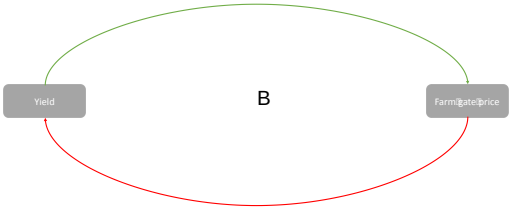

Figure 3: Balancing feedback loop, simple causal relationship

Figure 4: Two balancing loops connected

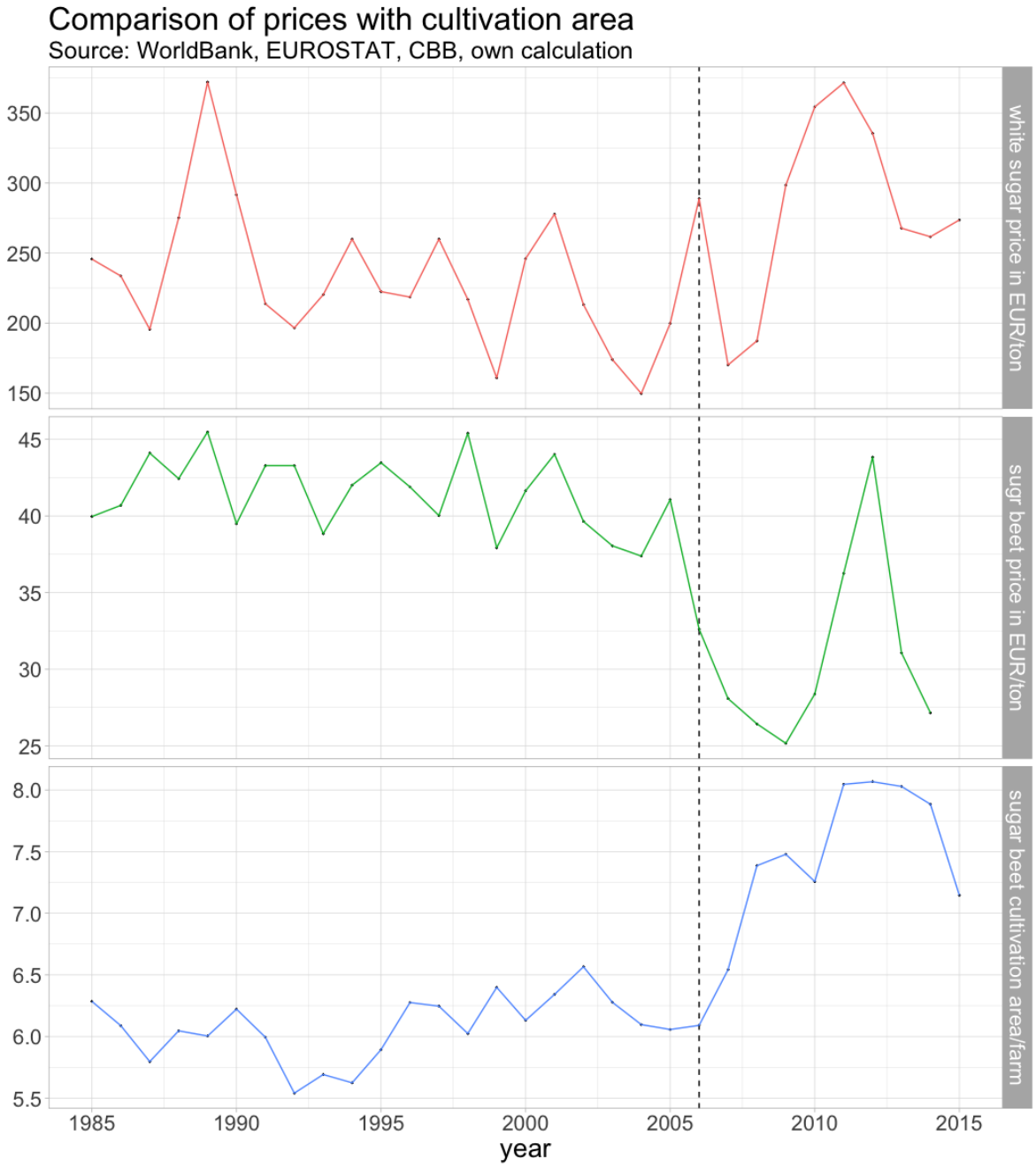

Figure 5: Fluctuation of price within a certain period of time. As one can see the range of fluctuation is greatest on the global level. The change rate for the white sugar price is 59,77947, for the sugar beet price it is 44,67898 and for the cultivation area it is 31,32354.

Based on the simple causal loop diagram, more variables can be integrated that reflect the actual situation. The price for sugar beet is influenced by substitutes, which is for sugar beet mostly sugar cane, which is imported. There are other substitutes, but not all substitutes have the same characteristics as sugar and thus are not perfect substitutes (Clemens et al. 2016). Therefore, we limit it here to sugar cane. Importantly, we have to acknowledge that at farm level, substitution of raw material by imports are limited (see (EU) No 1308/201). Only,

already refined material (raw sugar) is further processed within Belgium[2]. Therefore, the variable *supply limitation* is needed. This variable consists of perishability and transportability of the commodity. In the case of sugar beet perishability is high and transportability is low. Together these two factors lead to increased supply limitations, that explain why not much raw material can be imported. Because of the restrictions regarding supply, prices should tend to be rather high, incentivizing farmers to produce more. The same feedback loop applies for the refinery level. In contrast, however, due to the transformation of the raw material, perishability reduces and transportability increases, eliminating supply limitations. This means that the refinery has to deal with imports that pressure down prices. We can clearly see that the product characteristics determine the geographic scale of the market, which in the end affects prices. At refinery level, reduced supply limitations cause rather low prices, incentivizing refineries to produce less. This in turn affects the demand for sugar beet, hence prices, and hence how much farmers cultivate.

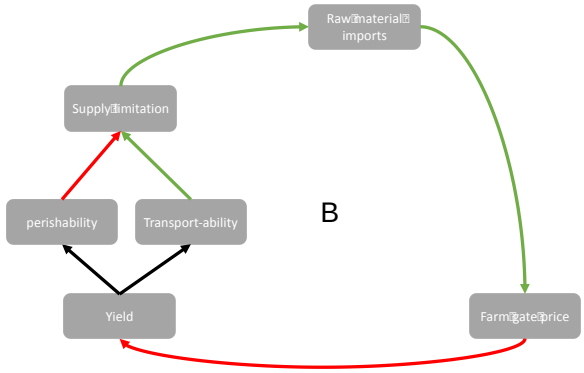

Figure 6: Farm level balancing feedback loop

More variables need to be added to get a better understanding of the mechanisms. During the interviews and focus groups participants stated that the refinery wants to increase production. However, looking at the causal loop diagram, that would not make sense. Increased production would mean even lower prices for the refinery, while they would need to pay more for the raw material. Another key factor here, is the costs of the refinery. For simplicity reasons, we did not distinguish between fixed and variable costs. Nevertheless, it is crucial to understand that the refinery does not work at full capacity, meaning that by increasing production they can reduce the per unit costs, making their operations more profitable. From this follows, that the more is produced the lower the costs and hence the higher the profit. While this explains why the refinery wants to increase production, it does not explain why farmers fear falling prices and the uneven bargaining power between farmers and refinery. If we follow the current structure, the refinery is induced to produce more (until unit costs cannot be reduced further), which leads to a larger demand for raw material and hence higher prices for farmers.

Not only characteristics of the commodity are key: also the number of buyers is. If it was easy to set up a refinery (entry barrier), more refineries in proximity to the cultivation area would exist and farmers could choose to deliver to the buyer with the best offer. In fact, this is not the case. Although there are two factories, farmers are forced to deliver to one factory, the closest. Therefore, we introduce the variable *sunk costs*, *number of refineries*, *buyer power* and *seller power* to the causal loop diagram. The low number of refineries increases the buyer power, meaning that as a buyer, refineries have a larger leverage on the farm gate price than the farmers have. Consequently, although the demand by the refinery rises, they are in the position to push down prices. Moreover, the supply limitations also affect the buyer power. If sugar beet would be a good that could be transported easily at low cost, farmers

[2] Similar to sugar beet, sugar cane needs to be refined quickly, otherwise it loses its sugar content S. Solomon, 'Post-Harvest Cane Deterioration and Its Milling Consequences', *Sugar Tech,* 2/1 (June 01 2000), 1..

would transport it to the refinery with the best offer. If sugar beet could be stored for a long time, farmers could wait until prices are better. But neither is the case. On the refinery level the low number of refineries does not lead to equal seller power due to the changing characteristics of the good in time. While the refinery can store and ship the good all over the world, other companies can do the same. Thus, the limited supply limitation reduces the seller power. This also means that if refineries want to increase their profits through prices, they have to do it on the buyer, rather than on the seller side. The causal loop diagram reflects the situation accurately.

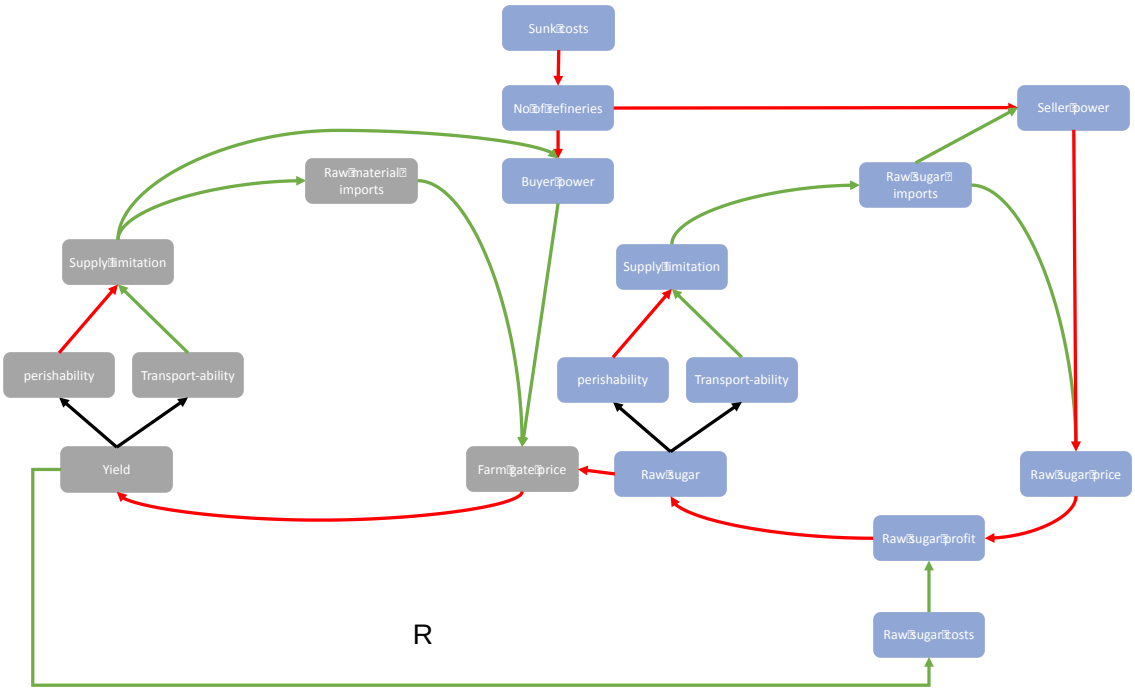

Figure 7: Causal loop diagram describing the dynamics between farm and refinery level

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. The factory needs more sugar beet to increase profitability. If farmers increase their production, they will worsen their situation (because of the reduced farm gate price), while improving the situation of the refinery (by reducing their unit costs). It is also understandable from the causal loop diagram why there are opposing points of view on the reason for changing prices. The refinery may want to increase production because of the unit costs. But the reason for doing so may be twofold. First, they may want to increase their profits. Second, they may need to produce at lower costs to be competitive on the world market. The second aspect may particularly be important for a company that is an international player.

Discussion

The analysis has shown that causal loop diagrams scan be a powerful tool to help understanding a complex situation. The definition of structure, conduct and performance within system dynamics differ slightly from the one of the SCP paradigm. For the SCP paradigm structure describes only the market structure, the conduct is interpreted as the behavior of companies and performance is understood as an indicator such as profit or efficiency (Lee 2007). Compared to systems thinking, this is a narrower definition of structure, behavior and performance. However, the understanding that the structure influences, behavior which in turn influences performance is the same. Moreover, the

distinction between intrinsic structural variables and derived structural variables[3] (Lee 2007), turn out to be pivotal for the analysis presented in this paper.

Clearly 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 market behavior. To illustrate this in the causal loop diagram, it would need to be extended further. For example, the structure of the system could change by new players entering or leaving.

Regarding our sugar beet case, farmers think about building their own cooperative refinery. In order to analyze the dynamics more variables need to be included. Some of these variables are already included in the general causal loop diagram. Particularly variables that determine the strategies of farmers would be needed. These are related to sunk costs (asset fixity), the access to capital, the access to land, social components (successor status), market conditions for other crops, biophysical conditions, etc. In the current situation farmers are set under pressure because of reduced prices. Since this would require farmers to produce potentially without costs being covered, they have to think about alternative steps such as changing crops, increasing scale, dropping out of agriculture, or build a new factory. All of these changes may lead (building a new factory will for sure lead) to structural changes within the causal loop diagram. These structural changes may then in turn affect power structures. Hence, systems thinking is not limited by the dynamics of dependent and independent variables.

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 large time 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.

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[3] "(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" Working Paper Series Vol. 2007-05..

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