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Managing essential inputs: the case of methanol supply in biodiesel industry

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ABSTRACT

This paper aims to discuss the ways that biodiesel producers manage the supply chain of methanol, an indispensable input obtained almost exclusively through importation. To build this discussion, it was firstly drawn the main features of the Brazilian biodiesel industry and, after that, it was described the main methanol's origins, applications and market. It was identified two ways on which biodiesel companies acquire methanol: a) via long-term contracts or b) in the spot market. If the first option means supply safety, the second one means more competitive prices. This qualitative study was built from two different data collection steps: a) participant observation and b) semi-structured interviews.

1 Introduction

The interest for the research in biofuels, especially in biodiesel, has grown significantly in the last few years. That reflects in an increase in biofuels articles published in scholarly journals. Some examples might be mentioned such Jupesta, Harayama and Parayil (2011), that build an analysis on the design a sustainable business model on the development of a biofuel industry in Indonesia; Babcock (2012), that discusses the market impacts of US biofuels and biofuel policies; Mcphail and Maimunah (2012), that bring to the light an important discussion about the challenge of producing biofuels and keep producing food in Malaysia and Maonga *et al.* (2015), that analyzes the critical and socioeconomic factors that leverage smallholder farmer's decision and willingness to adopt

mentioned right above, few papers have been addressed internal competitiveness of the biodiesel producers. It is especially rare to see papers that discuss strategies on the supply chain management in this industry. Some samples might be mentioned like César and Batalha (2011), that describe each competitiveness driver and presents a picture of the competitiveness of agricultural production and industrial production of the biodiesel supply chain and Sartori *et al*. (2009) that assess the implementation of crushing plants focused on the oil supply to small farmer's biodiesel facilities. None of them, however, discuss the day-to-day of decision process inside a biodiesel production company. This paper comes to start filling this gap.

The Brazilian biodiesel industry is very competitive. Since its creation by the government up to current days, yearly production soared from nearly 70.000 m³ in 2006 to approximately 3.400.000 m³ in 2014, according to the National Agency of Petroleum, Natural Gas and Biofuels (2015). To be profitable in a tough business environment as biodiesel's companies have to be diligent in cost control, supply chain management and logistics management. A company that is a leader in costs has the opportunity to catch higher margins.

The set of arguments above presented build the scenario to propose a study that focus on discuss the ways biodiesel companies in Brazil manage their essential inputs. It is put in the center of the discussion the supply chain management of methanol, an indispensable input to the biodiesel production that is almost totally imported. To address this objective, it was firstly described the biodiesel supply chain and secondly clarified the main methanol's origins, applications and markets. It was employed qualitative research methodology to perform the analysis of data collected in two different procedures steps: participative observations and semi-structured interviews.

2 Theoretical Framework: supply chain management (SCM) and supply chain disruption

Gibson *et al.* (2005, p. 17) say that the concept of SCM is a disparate set of descriptions. According to the authors, definitions may vary from narrow and functionally based perspective, such as regarding the management and control of materials, information and logistics, to broadly definitions that reach the integration of business processes from end users to original suppliers. Burgess *et al.* (2006, p. 703) go in the same way saying that, while interest in SCM is immense, it is clear that much of the knowledge about SCM resides in narrow functional silos such as purchasing, logistics, IT and marketing.

Boone *et al.* (2007, p. 594) affirm that SCM strategies and techniques are as varied as the disciplines from which they originate and the customers they are to serve. The complexity of relationships among the authors opens the opportunity to discuss SCM from a non-linear perspective. In this sense, Hearnshaw and Wilson (2013, p. 442) say that a linear approach of SCM as a dyadic relationship "grossly oversimplifies and distorts the realities of the modern supply chains. Choi *et al.* (2001) defend the same, saying that the linear view using dyadic analysis fails to adequately account for the interdependence between numerous heterogeneous firms present in supply chain systems.

Evolving the concept of interrelations among the players that compound a supply chain, Choi and Wu (2009) approach this as a joint of triadic relationships. This authors specifies nine buyer-supplier-supplier archetypes. Wu *et al.* (2010) say that in a buyer-supplier-supplier relationship triad, the buyer, as a contracting entity, influences the supplier's behaviors and the relationship between them. Still according the authors, by considering the relationships in such a triad, it is possible to gain a richer and more realistic perspective of buyer-supplier relationship. Hitt (2011) endorses the argument of supply chain as a complex joint of relation discussing its management covered by resource based view of the firm, transaction cost economics, organization learning theory and social capital approaches. In spite of being largely discussed in literature, Thomas *et al*. (2011) point out that a common accepted definition of SCM is still lacking.

Other important point to be considered in the conceptualization of SCM is the issue disruption. The concept of disruption of a supply chain is linked to the idea of risk management in supply chains. In this sense, Hendricks and Singhal (2005a, p. 696) mention that disruptions or, in their terms, glitches in supply chain are likely to adversely affect the short and long-term profitability of the firm. According to the authors, supply chain glitches can lead to loss in sales and market share, lower sales price due to markdowns of excess inventories and could prevent the firm from capitalizing on strong market demand due to unavailability of products. To avoid this kind of disruption or glitches, a diligent supply chain risk management is required. Ouabouch and Paché (2014) defend it saying that a multitude of more or less critical incidents along any supply chain may prevent a company from obtaining the expected level of logistics performance. Still according the authors, knowing how to anticipate and manage supply chain risks is therefore an important approach to maintain a competitive advantage.

Cousins *et al.* (2004, p. 556) argue that a firm part of a supply chain might be exposed to two particular risks: technological and strategic. The former is related to over-reliance in a single or limited source of a product, process or technology. The latter reflects the danger of being over-reliant on a single or limited number of suppliers. One case or another, Hendricks and Singhal (2005b) state that the risk of supply chain disruption is an indication of a firm's inability to match demand and supply.

3 Methodology

The data collection procedures were divided into two parts: a) participant observation, according to Guercini (2014) and b) semi-structured interviews. The first part was performed from January 2013 up to December 2014 and was realized within a biodiesel producer company. During this stage, the author had the chance to see how decision taker built and execute methanol purchase strategy. The author kept up with six processes of purchases in the spot market during this period of time. The main concern in this case was to get the best price at the spot market and, at the same time, assure a constant supply flow.

Being inside a biodiesel company has allowed the author to get in touch with managers of methanol supply companies. Because of this relationship rapprochement, it was possible to perform the second part of data collection. This stage, that happened between March 2014 and February 2015, was compounded by seven semi-structured interviews with three methanol supplier companies. The interviews approached global methanol origins and destinations, international and inland logistics and sales models applied in the Brazilian biodiesel market.

All the analysis performed on primary data were qualitative. The collection data procedures were rich of details and quality due to the fact that the author could be following activities inside a biodiesel company and because of the access to important methanol merchants that this opportunity gave to him. Beyond the robustness of primary data, the research question, focused on descriptive analysis, would be better answered by qualitative methodology. In this sense, Rynes and Gephart Jr. (2004) are assertive when defining qualitative research as method. According to this authors, it provides insights that would be hardly reached by quantitative method, giving the chance to understand the social processes that underlie management field.

Sutton (1997) advises that a qualitative research has to be conducted with rigor and criterion. This way, say the author, qualitative research will enjoy its legitimacy. Aiming to meet this requirement, it is presented right below a chart that brings the main characteristics of each of two steps that composed data collection procedures, as well as sort of information collected in each process. It will not be revealed the name of the companies or interviewees that kindly participated as data supplier to this study due to a matter of academic ethics.

Table 1. Characterization of data collection procedures and sort of information collected in each.

Data collection procedure	Main features	Sort of company
Active observation	Observation of six purchase processes at the spot market with one commercial manager.	Biodiesel producer (1)
Semi-structured interviews	Free conversation with seven commercial managers from methanol supplier companies that serve Brazilian biodiesel industry.	Methanol supplier companies (3).

Source: Elaborated by the author.

Each of data collection procedure was elaborated taking into consideration target information to be captured. The topics used to drive data collection in each kind of procedure is described below:

Active observation: strategy of purchasing at the methanol spot market; important logistics factors to be considered when building purchasing strategy; importance to have more than one methanol supplier when buying in the spot market; participation of methanol on total and variable costs of biodiesel production.

Semi-structured interviews: the main methanol origin areas; fundamentals of a long-term contract of methanol supply; the port logistics infrastructure needed to operate methanol in Brazil; the main concerns of biodiesel

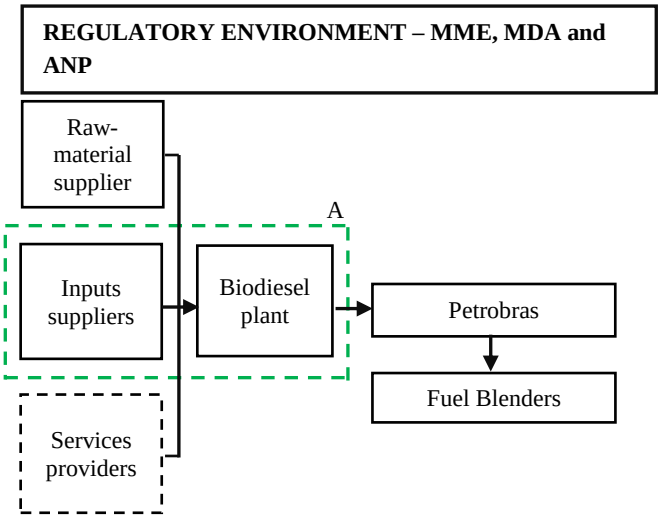
producers when they look for methanol supply.

4 Analysis

4.1 Characterizing Brazilian biodiesel supply chain

Brazilian biodiesel supply chain is highly controlled by government. Commercially, the Ministry of Mines and Energy (MME), via Petrobras, control the whole contractual system between biodiesel producers and fuel blenders. Concerning to industrial aspects, MME apply its control through the National Agency of Petroleum, Natural Gas and Biofuels (ANP). This agency takes care of aspects related to specification, quality, biodiesel x diesel mandatory blending attendance, among others. With regard to the social aspect, exclusive of Brazilian biodiesel industry comparing with the similar from other countries, the Ministry of Agrarian Development (MDA) names through the Fuel Social Stamp those companies that are small farming friend. The figure below illustrates the Brazilian biodiesel supply chain.

Figure 1. Brazilian biodiesel supply chain.



Source: elaborated by the author.

In this paper it will be focus the relationship between biodiesel plants and their input suppliers, highlighted above by the green dashed line (letter A). Specifically, it will be approached the strategies that the formers adopt to manage the supply of one of the most important inputs to the production: methanol. According to primary data, methanol corresponds to 60% of the total inputs used in biodiesel production or 8,5% of total variable costs (inputs + raw-material).

4.2 Characterizing methanol origin, applications and market.

Methanol or methyl alcohol is a colorless liquid produced from synthesis gas (a mixture of carbon monoxide, carbon dioxide and hydrogen) (Pereira and Andrade, 1998; Cummins *et al.*, 2010). This product is widely used in chemical industry as raw-material (Pereira and Andrade, 1998), feeding in special formaldehyde production process. Cummins *et al.* (2010) and the Brazilian Agency of Industrial Development (2012) say that formaldehyde is basic raw-material used in the production of common products such as particle boards, medium density fiberboard, plywood, paints, foams, rubbers, solvents, fuels and pesticides. In addition to the applications mentioned above, it might be pointed out other kind of application as additives for gasoline, solvents and anti-freezes, or in the biodiesel production process (IEA-ETSAP, 2013).

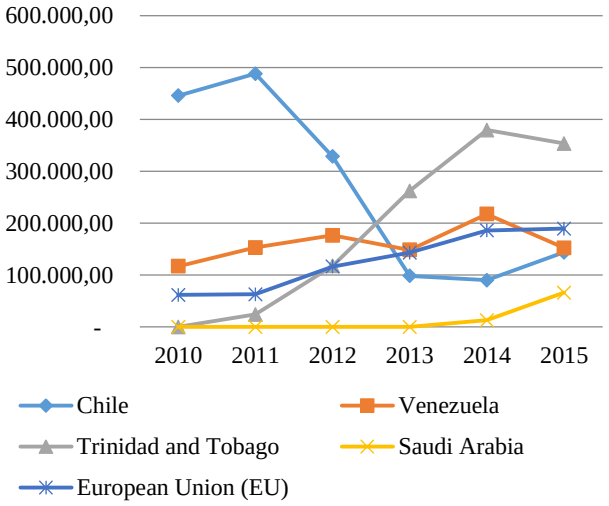
In 2012 global methanol production was about 45 million ton, strongly based on fossil fuels, mainly natural gas (IEA-ETSAP, 2013). However, this product may also be produced from other carbon-containing feedstock such as biogas, biomass, waste streams and CO_2 (IEA-ETSAP, 2013). Coal is pointed out as an important raw material for methanol production as well (EPA, 2010; National Energy Technology Laboratory, 2014).

According to Dolan (2013), geographical concentration of methanol production plants changed drastically from 1999 and 2010. Production capacity in North America and Western Europe fell down from 13,3 million ton in 1999 to just 900.000 ton in 2010. In the same time, still according to Dolan (2013), production capacity jumped from 13,1 million ton to over 24 million ton in South America, mainly in Trinidad and Tobago and in the Middle East. However, nothing is similar to the increase in production capacity seen in China. From 1999 to 2011, Chinese production capacity grew up from 1,2 million ton to roughly 40 million ton (Dolan, 2013). This movement was driven by the fast increase in natural gas feedstock costs in the pioneering industrial regions.

Farias (2014, p. 54) says that Brazil is a net importer of methanol by having a demand of

952.000 ton versus a production of 206.000. According Rodrigues (2011) and the National Agency of Petroleum, Natural Gas and Biofuels (2012), the annual production capacity of the country in 2012 was 309.500 ton divided amongst three companies, namely GPC Química (220.000 ton), Companhia Petroquímica do Nordeste (COPENOR) (82.500 ton) and Vale Fertilizantes (7.000). Interviewees consulted during primary data collection process confirmed that national production capacity has not changed from 2012 to 2015. According to the Ministry of Development, Industry and International Trade (2016), it was imported in 2015 US$ 288.374.778,00 or almost 842.000 ton. Still according to that Ministry, from this total, 353.574 ton was brought from Trinidad and Tobago, 152.324 ton was shipped from Venezuela and 143.700 ton was imported from Chile. The three countries latter mentioned have production plants of two of the biggest players in the global market, namely Methanex and Mitsubishi. Figure below brings participation of the main supplier countries in Brazilian exports since 2010

Figure 2. Main Brazilian methanol suppliers (2010 – 2015) in ton.



Source: adapted from the Ministry of Development, Industry and International Trade (2016).

The Methanol Institute (2013) shows that it is needed around 10% of methanol to produce 100% of biodiesel. Taking into account that in 2015 biodiesel plants sold 4.054.667 m³ of biodiesel to meet internal market demand and considering the methanol yield above mentioned, it is possible to deduce that it was used around 356.810 ton of this product only to feed biodiesel production. It is remarkable the importance of this input to biodiesel production. Table below shows the estimated consumption of methanol by biodiesel industry and total demand vis-a-vis internal production and imports of this input.

Table 2. Methanol Supply and Demand in Brazil – (2008 to 2013) – and participation of biodiesel in total demand.

Item	2010	2011	2012	2013
Internal Production	206.000 t	206.000 t	206.000 t	206.000 t
Imports	563.193 t	671.428 t	637.869 t	750.338 t
Total Supply	**769.193 t**	**877.428 t**	**843.869 t**	**956.338 t**
Total Demand	**769.200 t**	**877.400 t**	**843.600 t**	**952.800 t**
Net result (supply – demand)	**-7 t**	**+28 t**	**+269 t**	**+3.538 t**
% Biodiesel on total Demand	**27%**	**27%**	**28%**	**27%**

Source: adapted from and Farias (2014), National Agency of Petroleum, Natural Gas and Biofuels (2016) and the Ministry of Development, Industry and International Trade (2016).

4.3 How do biodiesel companies manage methanol supply chain?

The huge amount of methanol used to feed biodiesel industry comes from Santos (SP) and Paranaguá (PR) ports. It means that the most part of this input is brought from international markets. Some exceptions are seen in the case of biodiesel producers placed in North and Northeast Brazil that take methanol from domestic suppliers as Copenor in Camaçari (BA). These biodiesel players are PBio (Bahia), PBio (Ceará) and Oleoplan (BA). The following discussions will be focus on the contractual relationship between biodiesel players and methanol suppliers import this input through the two ports above pointed out.

Five important companies prevail in Brazilian methanol supply chain dedicated to biodiesel production, namely Methanex, Mitsubishi, QuantiQ, Tricon Energy and Copenor. The two former companies are two of the most important methanol producers and trading company globally. QuantiQ is a Brazilian trading owned by Braskem holding. This company

operates methanol only in Brazil. Tricon Energy is a global trading company focused on Petrochemical products, among them methanol. This company don't produce methanol. And Copenor, as per mentioned, is a Brazilian producer. In Paranaguá (PR) and Santos (SP) ports they operates with their own product produced in Camaçari (BA) or with imported product.

Methanex, the world's largest methanol producer and supplier (Methanex, 2014; methanol institute, 2015), makes business in Brazil only in two ways: a) selling in the spot market through intermediate players/distributors companies, like QuantiQ and Copenor, or b) selling via long-term contract directly to the biodiesel producer. In the first option, the intermediaries are responsible for all customs procedures to nationalize product in Brazil and make it free for loading by biodiesel purchasers. In the second option, Methanex deliver the product inside tanks rented by itself and the biodiesel player takes care on the customs procedures.

On the other hand, Methanex's most important competitor, namely Mitsubishi, offers the two ways of commercialization as Methanex does, but, in case of spot market, with no intermediaries. Mitsubishi, differently from Methanex, has a subsidiary in Brazil. It allows the company to deal by itself the full custom procedures and deliver product nationalized to the biodiesel producer.

QuantiQ, Tricon Energy and Copenor only offer product in the spot market. Being Methanex's distributor, QuantiQ and Copenor count with huge confidence in terms of supply guarantees. On the other hand, Tricon Energy is a pure trading company with no liaison with methanol's suppliers. This company tries to catch purchase opportunities in the Middle East and Asia and bring this product to Brazil. If in one hand they are very competitive in prices, on the other hand they eventually might disrupt methanol supply in Brazil due to problems on the origination side.

The annexes 1 and 2 brings in a systematically way each of the mentioned companies work and a scheme that shows how each of the companies manages their methanol supply chains

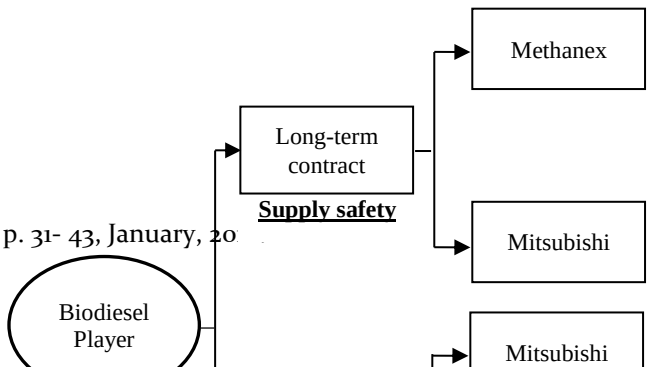
It is in that methanol supply scenario that a biodiesel producer has to manage the supply chain of this important input. To deal with this, a biodiesel player has basically two options: a) Buying methanol via long-term contract or b) Buying methanol in the spot market. Eventually, a biodiesel player might mix both strategies, but, in this case, long-term contract sellers tend to increase the parameters used to build de price. In this case, then, methanol price get higher. This mixed strategy is not common.

In a long-term contract, offered by Methanex and Mitsubishi, a biodiesel player finds supply safety. As both companies have facilities in South America and have good tank space in the port, they may give the purchases this guarantee. These contracts might have from one to three years duration. Sale price is defined by a formula that takes into consideration an international price reference plus international logistics and port costs.

In the spot market, biodiesel players have to be in straight contact with the suppliers to understand product availability and to try to catch some opportunity to buy a lower-price product as well. The critical point here is supply safety. An important event that happened first half 2015 may illustrate this point: in April 2015, an Ultracargo liquid terminal burned on fire in Santos due to and leakage. This incident caused serious damage to the supply of methanol to biodiesel industry. In that case, those who were used to operate in spot market suffered with supply chain disruption, while those that held long-term contracts had their flows kept by product coming from Paranaguá (PR).

An important competitive advantage of operating in spot market is, undoubtedly, the capacity to get very good opportunities in prices, mainly playing with competitive suppliers as Tricon Energy. But, on the other hand, if biodiesel player chooses this way, it is necessary to bear in mind that it needs both good tank storage capacity and an accurate logistics planning and execution. Figure below shows possible contract's flows from biodiesel player's point of view.

Figure 2. Possibilities of contract per supplier.



Source: elaborated by the author.

5 Conclusion

This paper aims to discuss the ways that biodiesel producers manage the supply chain of methanol, an indispensable input obtained almost exclusively through importation. To do so, it was firstly described the biodiesel supply chain and secondly clarified the main metanol's origins, applications and markets. It was employed qualitative research methodology to perform the analysis of data collected in two collection procedures steps: active observations and semi-structured interviews.

Methanol is an important input to biodiesel industry. It represents 60% of cost spent with inputs and 8,5% of total variable costs. This numbers show the importance of this input that is almost totally imported. Biodiesel companies have to be diligent on supply chain management to avoid supply disruption or glitches (Cousins et al. 2004; Hendricks and Singhal, 2005b; Ouabouch and Paché, 2014). Hendricks and Singhal (2005a) highlight the importance of a diligent supply chain management saying that supply chain glitches can lead to loss in sales and market share, lower sales price due to markdowns of excess inventories and could prevent the firm from capitalizing on strong market demand due to unavailability of products.

It was identified basically two ways to purchase methanol in Brazil: a) via long-term contracts or b) in the spot market. Five companies are on the spotlight when the subject is methanol supply to Brazilian biodiesel industry: Methanex, Mitsubishi, Tricon Energy, QuantiQ and Copenor. These companies have different ways to act in the Brazilian methanol market. These differences will induce biodiesel producers to purchase from one or another depending on their interests and needs.

Methanex and Mitsubishi have very similar ways to manage business in Brazil. Both work with the two commercialization modalities. The difference between them is that the former doesn't have subsidiaries in Brazil and, because of that, only deals in the spot market via distributors and the latter do have subsidiary in the country. It means that Mitsubishi is ready offer nationalized product to purchasers when the sale is done in the spot market, while Methanex has to use QuantiQ or Copenor to participate in this modality.

Both purchasing modalities have pros and cons. Buying in a long-term contract will give to biodiesel producer the guarantee of supply. Mitsubishi and Methanex are two of the largest methanol producers worldwide. This position gives them flexibility to bring product from a set of facilities. If safety is guaranteed, it is not possible to say the same about competitive prices. On the other hand, operating in the spot market gives to the biodiesel producer the possibility of getting better prices. Tricon, for example, use its know-how as petrochemical trading company to find out cheaper methanol resources all around the world and offer its product to the Brazilian biodiesel companies. In this case, biodiesel producer must be aware about the eventual supply disruption risk and execute a diligent supply chain management to avoid this situation.

This paper brings to the light the approach of supply chain management and supply chain disruption to an industry that is poorly explored on this: Brazilian biodiesel industry. Other inputs and even raw-materials would be approached in the same conceptual background, but none of them would represent in the clearest way the risks of disruption in supply chain than methanol. This input arises with two important issues: it is essential and cost-representative to the biodiesel industry and it is almost fully imported.

Studies that address discussions on supply chain management and supply chain disruption on the sort of raw-material used to feed biodiesel industry would help to evolve supply chain management and supply chain risk management to this important industry in Brazil. In the same way, studies that address deeply the origins, applications and global flows of methanol would help to discuss the risks involved with this input not only in the Brazilian biodiesel industry, but in other important sectors as well.

6 Implications and Further Research

Academically, the findings of this study contributes to add one more piece on the concept of supply chain management regarded to biodiesel industry. Studies on this industry having SCM as theoretical background are much more focused in raw material supply chain issues, putting aside the important strategic group of inputs supply.

This paper also brings important contribution to the professionals that deal with biodiesel industry. To those that is inside biodiesel industry managing the daily basis commercial operations, it is important to have a better understanding on how methanol supply chain is organized and thus having enough subsides to take the better decisions. To those professionals that deal with Merger and Acquisitions (M&A) in companies that are willing to embark in biodiesel market, this work may be helpful in addressing in details the risks and traps of inputs strategic group.

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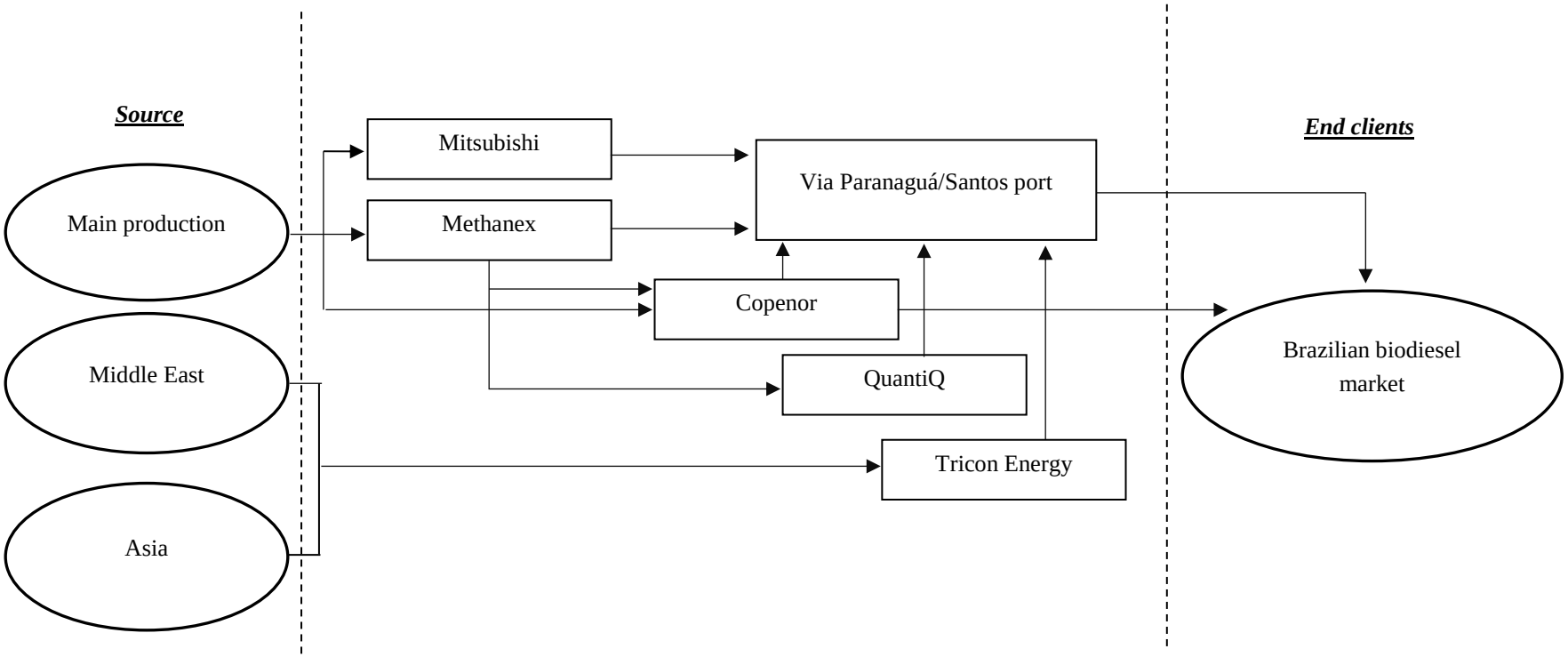
Annex 1. Features of the main methanol suppliers to Brazilian biodiesel market.

Methanol Supplier	Main features	How does each company manage supply chain?	Advantages	Disadvantages
Methanex	Largest world's producer and supplier. Strong position in South America due to its industrial plant in Chile and in Trinidad and Tobago. Doesn't have subsidiary in Brazil.	Operates in spot market via distributors or in long-term contracts directly with end-users.	a) Guarantee of supply.	Prices are not very competitive.
Mitsubishi	One of the largest world's producer and suppliers. Strong position in South America due to its industrial plant in Venezuela and in construction plant in Trinidad and Tobago. Holds a subsidiary in Brazil.	Operates in spot market or in long-term contracts with end-users both directly.	a) Guarantee of supply.	Tough process of credit analysis.
QuantiQ	National company that deal with methanol exclusively in Brazil.	100% Methanex distributor	a) Guarantee of supply.	Prices are not very competitive.
Tricon Energy	International trading company that trading petrochemicals and fuels globally, among them methanol. Does not have industrial plant.	Looks for purchasing opportunities all around the world, mainly Middle East and Asia, and ship the product to Brazil.	a) Prices are competitive.	Risk of disruption in supply.
Copenor	Brazilian methanol producer.	It may operates both sides, i.e., distributing its own methanol (generally in North and Northeast Brazil) and distributing Methanex's methanol via Paranaguá and Santos ports.	a) Prices are competitive. b) Guarantee of supply.	

Source: elaborated by the author.

Annex 2. Methanol supply chain focused on Brazilian biodiesel industry.



Source: elaborated by the author.