Original Research Article

The impact of intermediary firms on marketing genetically modified livestock products

Abstract

Agricultural biotechnology, by changing the process of agricultural production in the agrifood sector, has posed serious challenges for the industry. The fundamental problem is that the biotechnology industry, with tremendous vertical integration from the research sector through to farm gate, has still relied upon decentralized markets to commercialize their products. Their innovations have for the most part been left to find their own consumer markets. This paper examines the theory of market making and the role of intermediaries in creating new markets and hypothesizes that without intermediation in the biotechnology market, the optimal market size will not be realized, reducing private research investment and depriving society of the potential social gains of this new technology.

Keywords: GM livestock products; intermediary firm; market-making.

JEL codes: M21, M31, Q10, Q13

1. Introduction

Although the adoption of modern biotechnological procedures in the agrifood sector promises great benefits and production efficiency for the industry it creates serious challenges for its stakeholders, including products' developers, products' marketers, distribution channels, consumers, regulatory agencies, and policy makers. To date, biotechnological innovations have had great impact on plant-based agriculture and livestock products. Since the first genetically modified (GM) foods came into market the biotech companies have been trying to promote these types of products and changing the status of markets from being niche to become more

spectrums of point-of-sales. It is a general consensus that GM livestock products are scientifically safe and provide sufficient capacity to meet ongoing increased in demands for food worldwide. In addition, more nutritional values, various applications from agriculture to medicine, more resistance to diseases, improved quality of life for consumers by advancing their health and, as a result, reduces the heavy pressure on public budget. Opponents of consuming GM livestock products argue that these products have not been tested enough and their effects on consumers' health and environment are ambiguous (Medindia 2013, Nielsen and Anderson 2000). Moreover, the commercialization of GM livestock products require substantial amount of time and money spent on promoting these types of products in the market, which implies that the customer acquisition rate would be high if they were not promoted as much efficient as it were possible. It is noteworthy to mention that Article XX of the General Agreement on Tariffs and Trade (GATT) requires each country to set its own regulations and policies for trading GM foods from both environmental and food safety aspects. This makes international trade more sophisticated between trading partners. As Haghiri and Kerr (2008, p.101) pointed out "the centerline of international trade debates no longer hinges on issues such as tariffs levels, the size of import quotas, and elimination of nontariff barriers through conversion to tariffs. Instead, current negotiations encompass broader subjects in international trade including grade and quality standard procedures, sanitary and phytosanitary regulations, rules of origin, labeling requirements, inspection procedures, government procurement, environmental standards, professional certification, protection of intellectual property rights, public health policy, animal welfare, labor standards, and subsidization mechanisms." In addition, trading partners are facing some obligations, such as (*i*) most-favored-nation (MFN) treatment, and (*ii*) customs transparency that are set in GATT. The former policy emphasizes on establishing equality of trading opportunity amongst states by changing bilateral agreements to multilateral ones that ultimately led to enhance economic efficiency through strong competition in international transactions. The latter policy acknowledges more transparency in tariffs and rules of origin between members of World Trade Organization (WTO), which might stem from lack of publicly available information among trading countries. We should add that trading livestock products in international markets have also been exposed to sanitary and phytosanitary (SPS) measures and technical barrier to trade (TBT) agreements that must be taking into account by all WTO members to avoid the inevitable trade disputes among them (Nielsen and Anderson 2000).

The fundamental problem is that the biotechnology industry has relied upon decentralized markets to commercialize their products. While there has been increasing vertical integration from the research sector through to the farm-gate, most of the genetically modified (GM) products leaving the farm-gate and entering the processing and food chain have been left to find their own markets. This approach to market making can work when the quantities supplied and demanded, consumers' willingness to pay and sellers' opportunity costs are known. The biotechnology sector does not exhibit those traits. The credence-like attributes of biotechnology products result in uncertain demand and widely varying estimates of consumers' willingness to pay. Furthermore, high fixed costs (due to research and development expenses) and low variable costs yield decreasing returns to scale to the industry, which complicates the discovery of quantities and the opportunity costs of supply.

The main objective of this study is to examine the theory of market making and the role of intermediary firms in creating new markets for trading GM livestock products. The paper hypothesizes that in the absence of intermediary firms for distributing biotechnological livestock products, the optimal market size will not be realized, reducing private research investment and depriving society of the potential social gains of this new technology. The rest of paper is as follows. Section 2 presents the status quo of the market in the biotechnology sector, comparing and contrasting the experience in the crops industry with the potential in the livestock sector. Section 3 reviews the relationship between intermediary firms and market microstructure. Section 4 examines the theory more closely to determine the conditions that favor intermediation over decentralized trade. Section 5 briefly lists the differences between intermediation and decentralized markets. Finally, Section 6 concludes some remarkable points, discusses implications, and provides new venues for further research.

2. Background

The history of using knowledge-based technology in the agricultural industry dates back to 23 years ago when a Californian company, i.e., Calgene submitted the first commercially grown GM tomato, namely Flavr Savr^{TM}, to the U.S. Food and Drug Administration (Redenbaugh et al. 1992). Since 2011, there have been 11 different transgenic crops modified to incorporate herbicide tolerance, insect resistance, viral resistance, abiotic stress resistance or output/quality traits. The introduction of all these new varieties of knowledge-based crops have welcomed by

farmers as between 1996 and 2012, the total arable area cultivated under GM crops were increased from 4.2 to 426 million acres; i.e., a 100-fold increase, in 30 countries on all 6 continents (James 2014). Although the rate of adoption and commercialization of biotechnological products in the crops sector is unprecedented their sales require substantial amount of time and money spent on finding proper marketing channels. The problem stems from the fact that the market is segregated into two major blocks. The first block contains countries such as the United States, Canada, Australia, and Argentina where the knowledge-based GM products have been adopted and used, whereas the second block, which mostly includes European Union countries, prohibited the production, consumption, and distribution of any GM products since 1998 (Adams 2014). Since different policies have been implemented in these countries such disparity in public acceptance on using GM products is inevitable. As Anderson and Jackson (2003) stressed not all the European countries approved GM products for various reasons including political, cultural, religious, and lack of public awareness. On the contrary, in some countries like the United States and Canada a series of ex post process is taking into account to, first, examine the GM products in question, and then market the products that are passed through several stages of verifications. In addition, households and firms' attitudes and expectations in consumption and production of GM products associated with the institutional environment and types of market structure should not be ignored. For instance, Bernauer and Meins (2001) argued that, in the European Union, non-governmental organizations' pursuant activities in changing environmental institutions to expand the capacity of producing GM products combined with the collegial operations of social media in promoting the consumption of GM products has yielded the current rigid regulations in the industry. On the contrary, in the North America and especially in the United States, there is a significant gap between the group interests of producers and consumers of GM products. The strong lobby of agri-biotechnological companies and the non-unionized behavior of consumers are the main reasons that cause a rift between these groups of economic agents. The aforementioned estrangement stems from the fact that most of the GM products are classified under the credence group of products. When the consumption effect of a product on consumers is difficult (or sometimes impossible) to be measured, the product is known as a credence one. From economic perspective, it can generate an asymmetric information status in the market at the expense of consumers and in favor of genetically modified goods producers because the benefits or risks of consuming such products cannot be recognized by the former group through either search or experience. Therefore, to sell

GM products both retail and wholesale markets need to be meditated for quality assurance. How much consumers will purchase GM products in each country depends on how trustworthy the food safety regulatory systems are in the country. The more well-organized and proper-structured a food safety regulatory system is, the more private firms are able to introduce new GM products to the consumer's markets, and as a result markets for these types of products are developed.

The food incidence of the causal link between bovine spongiform encephalopathy and new variant Creutzfeld-Jakob disease which first began in the United Kingdom in 1996 and then spread over France and Germany four years later caused public mistrust in the regulatory systems (Gaskell et al. 1999). Consequently, the commercialization of new GM products ran into serious problems in the absence of public confidence. As a result, markets for GM products in general and livestock GM products in particular have been defacto closed to the new technology. To solve the problem, the establishment of new institutions whose main task is to mediate GM products and provide necessary information to assure consumers from the safety of these types of products was imperative more than before. The emergence of such new institutional economics was seriously required since the adoption rates of GM crops had been decreased in late 1990s. Literature shows that Canada's exports of varieties of GM canola and US GM maize to European countries were ceased in 1998, thus, other countries such as Australia, Central European countries, and Argentina began to export substantial amounts of GM canola and maize to the European Union (Anderson and Jackson 2003). Such shifting in major GM-products exporting countries caused a significant delay in investment on research and development of these types of products worldwide which could turn away the investment in agricultural biotechnological companies. One outcome of such delay was that the trade has been disrupted and marketing costs have begun to rise. Consequently, life science companies announced to divest of their agricultural biotechnology operations. For example, Upjohn Pharmacea reduced its stake in Monsanto in early 2000s to 85 per cent and had plans to go to a minority interest shortly; Aventis (AgrEvo and Rhone Poulenc) had announced it would spin off its merged agbio division as Agreva; and Novartis and AtraZeneca declared that they restructured their agbio division under the name Syngeria. If we assume that none of the divested units would have internally generated funds large enough to continue their current rate of research and development (R&D), then it is expected that financial markets through its financial intermediaries will scrutinize their

operations because they might have found some of the investments unattractive. In short, the failure to gain access to the global market for these new GM crops will lead to lower investment in coming years. It is a common question for governments, livestock producers and processors and that how biotechnology will affect marketplace in the livestock products.

In the livestock sector, there are three main GM products that could require greater market-making efforts. First, the earliest biotechnology impact on the livestock sector involved GM vaccines and hormones. The first GM hormone, recombinant bovine somatotropin (rBST) was introduced in the U.S. in 1994. According to the USDA survey data, the use of the hormone was raised to 44 per cent in 2005 and then declined to 16 per cent in 2010. The reasons that could justify the declining rate of using rBST in the U.S. dairy cattle were two-fold. First, it was observed that the risk of culling associated with the use of the hormone in multiparous cows increased. Second, the information showed that the risk of non-pregnancy was raised. The combination of the two aforementioned reasons would probably lead to decrease the lifespan of dairy cattle. Health Canada banned the use of rBST in dairy cattle throughout the country. The same decision was made by other nations such as Argentina, Australia, Japan, New Zealand, and the European Union (EU). It is worth mentioning that the dairy industry was not the only one that was affected by the trading partners' decisions. In 1981, the EU began to impose restrictions on imports of U.S. beef grown with animals treated with growth promotants (not a recombinant product) which was gradually implemented and completed in 1989 and extended until 2003 (Johnson 2015). Meanwhile, Canadian Food Inspection Agency (CFIA) reported that there are more than 100 GM veterinary biologics for cattle and hogs that have been developed and approved for use in Canada and the US (CFIA, 2019). Veterinary biologics are animal health products such as vaccines, antibody products, and in vitro diagnostic test kits that are used for the prevention, treatment, or diagnosis of infectious diseases in animals, including domestic livestock, poultry, pets, wildlife, and fish.

Second, there is significant debate amongst livestock scientists about whether livestock fed on GM feeds should be treated differently than livestock fed on traditional feeds (Vicini 2017). It is worth mentioning that soybean was the first GMO crop which was commercialized in 1996. The product was resistance to glyphosate that was an active ingredient in Roundup herbicide (Parisi et al. 2016). At present, eight GMO crops are commercialized in the U.S. agricultural sector. These crops are alfalfa, canola, corn, cotton, papaya, soybean, squash, and sugar beets. Among

them, only papaya and squash are not being used as animal feeds (Vicini, 2017, p.10). The above GM crops could be herbicide tolerance, insect resistance, drought tolerance, disease resistance, or reduced lignin. Nevertheless, they are assumed to be products with credence attributes. A product with a credence attribute is the one with qualities that cannot be observed by the consumer after it is purchased making it difficult to assess its utility. Although livestock producers and consumers gain benefits from these types of products both groups may not perceive those benefits (Herring and Paarlberg 2016). While scientists assert that the genetic modifications of the feed do not cause any detectable impact on the meat, some consumers groups have challenged the products and some food chains and governments have responded. In Belgium Aholt has announced that it will no longer sell meat fed on GM corn or soybeans while the UK, Netherlands and EU governments are examining the possibility of requiring special labels on meats fed on GM feeds. In absence of any intermediary for livestock fed on GM feeds, the market could fail.

Third, there is some possibility that biotechnology techniques could be used to modify the genetics of cattle, hogs, sheep or poultry to display desirable consumer traits, such as marbling, tenderness, color and taste. There is significant effort underway to encode the genome of ruminants to enable this work. For example, transgenic pigs are designed for xenotransplantation, 'Dolly the sheep' is for use in pharmacological studies and Nexeria's goats will produce silk proteins for industrial applications. These applications are well mediated. If this technology is expanded to the commodity food sector, intermediation will be necessary to develop the market. In short, the global livestock sector has some breathing room, but it should learn from the mistakes in the crop sector. There are greater risks if market making is left to decentralized markets, especially given the recent decline in public confidence in regulators, who previously mediated some of the market making.

3. The relationship between intermediary firms and market microstructure

The concept of microstructure applies to any fields of economics in which the main concerns are trading and market structure, market rules and fairness, success and failure, and how the design of the market affects the exchange of assets, price formation, and price discovery (Teall 2018). In general, an intermediary is an economic entity who purchases from suppliers for resale to buyers

or who helps buyers and sellers meet and transact, therefore, acting as middlemen between buyers and sellers (Haghiri 2017, Spulber 1999). These new institutional economic enterprises seek suppliers, find and encourage buyers, select buy and sell prices, define the terms of transaction, manage the payments and record keeping for transactions, and hold inventories to provide liquidity or availability of goods and services. In this paper, we examine the economic role of biotechnological firms in livestock products and the functioning of agro-biotech markets in general. Just as producing goods and services use resources, the establishment and operation of markets to allocate those goods and services also consumes scarce resources. Agricultural biotechnological companies incur costs in adjusting prices and communicating price information to buyers and sellers. However, the types of information these companies can obtain from the market-response are not perfect and because of that they need intermediation activities from other firms. The intermediaries play their roles in the market in different situations. When there is demand and supply randomness, intermediate firms provide liquidity or immediacy by standing ready to buy and sell. Moreover, even if there is no intention or willingness to pay or opportunity costs of trading between partners, intermediaries can coordinate transactions by matchmaking and brokering activities. Sometimes the characteristics of buyers and sellers are unobservable, which requires the intermediate firms to generate market information and provide guarantees for product quality to address adverse selection. When the actions of buyers or sellers are costly to observe, intermediaries provide monitoring and contracting services.

The main function of market intermediaries is to find methods of clearing the market that is, pricing to match purchases to sales. This price-setting activity provides explanations for the question of how market-equilibrium prices are attained. Samuelson (1980) and other neoclassical economists have made tremendous efforts to provide solutions to the problem by providing answers to the following three questions: what goods to produce and in what quantities, how to produce them, and for whom particular goods are produced. Stiglitz (1993) added a fourth question and referred to the identity of decision-makers and the circumstances under which the information is acquired. Spulber (1999) summarized all the four questions into one (i.e. “who decides”), which could be answered by the presence of firms. This means that firms are now the decision making units with managers act like as decision-makers and strategists.

Biotechnological companies determine what goods and services to produce and in what quantity, given the market circumstances. It is worthy to mention that some of these companies may act as their own intermediary firms. If it is the case, then the companies can provide answers for the four questions by making decisions about the mix of products they will purchase from suppliers, which suppliers to contact with, and the allocation of goods and services to be offered to their consumers. The main advantage of operating as intermediary firms is to lessen transaction costs for these companies because they do not need to spend time identifying merchants and manufacturers. In addition, intermediary firms are able to transport, store, repackage, assemble, prepare for final use, and add information and guarantees thereby adding value to the biotechnological products.

We adapted the Spulber (1999) model to demonstrate the role of intermediaries in a circular flow of an economic activity (Figure 1). In every circular flow diagram, three economic agents can be found: *consumers*, *market-takers (firms)*, and *market-makers (intermediaries*). Consumers who may be willing to pay a premium price to purchase genetically modified livestock products depending upon their revealed preferences. Consumers' purchasing habit is the core of the revealed preferences models. Consumers send expenditures to market-takers in return for biotechnological livestock products demanded and receive incomes from intermediaries in return for inputs supplied. Biotechnology companies take price signals and market institutions as givens. In contrast, market-makers create and operate markets. Intermediaries or market-makers are those agricultural biotechnology companies (e.g., BASF, Lonza, DNA Tech, AgBiome, DuPont Industrial Biosciences, Ecovative Design, Bayer, Caribou Biosciences, etc.) whose main role is to act as a price-making entity and go beyond other market institutions such as organized exchanges for financial assets. Stakeholders in the industry have some concerns about how prices are adjusted in these types of markets to make quantity supplied equal to the quantity demanded (i.e., the market clearing condition). In a perfect competition, agricultural firms simply react to prices. Since agricultural biotechnology products are differentiated from other goods in the same category, it provides some market power for the biotechnology companies. This is strengthened by other factors such as transportation costs, consumer switching costs, transaction costs, barriers to entry, intellectual property rights, and incomplete information about prices. Nevertheless, setting prices in the market is costly for these companies, so we recommend that some of the biotechnology companies should act as intermediary firms. The intermediary firms gather

information required for setting market-price, monitor competitors' economic behavior, incur menu costs in changing prices by printing new catalogs or issuing price lists, arbitrage between buyers and sellers, and coordinate their transactions through price signals.

[Insert Figure 1 here]

For an in-depth discussion on how intermediary firms could operate in the market, we present a simple bid-ask price model in the agricultural (livestock) biotechnology industries that describes one of the roles of the intermediary firms in clearing the market. Assume a biotechnology intermediary company that has some market power in both the goods and services and suppliers markets. Such possession of the dual market power for a biotechnology intermediary firm is possible whenever it is the primary purchaser and reseller of a differentiated product. Therefore the firm is able to set both bid and ask prices for its product and to make profits from the markup between the two types of prices (Figure 2).

[Insert Figure 2 here]

In Figure 2, both demand and supply curves represent residual demand and supply for the products of the biotechnology company. The demand curve shows the residual demand of the firm's customers, and the supply curve indicates the residual amount that the company's suppliers are willing to provide at various factor prices. Having the knowledge of the residual demand and supply functions for the biotechnology intermediary firm is essential since it chooses the optimum buy-and-sell prices to maximize its profits. In Figure 2, W represents the bid price (offered to sellers), and P shows the ask price (proposed to buyers). The seller's supply function is $S(w)$ and the buyer's demand is $D(p)$. To maximize its profits, the biotechnology intermediary firm sets prices to equalize its marginal revenue and marginal factor cost. The profit-maximizing bid and ask prices are W^* and P^*, respectively, the quantity transacted amount is Q^*, and the profit-maximizing area is $(P^*\text{-}W^*)\,Q^*$. Figure 2 shows that the profit-maximizing buy and sell prices spread out in a range so that the Walrasian price P^w is included. In this case, the level of output, which is chosen by the biotechnology intermediary firm, is determined at the

level that is below the Walrasian output level Q^w. There are many factors involved in determining the bid-ask spread prices. Amongst these factors, the elasticity of supply and demand, the company's transaction costs and the alternatives available to buyers and sellers are important. It is worth mentioning to the mechanism that enables the biotechnology intermediary firm to clear the market by practicing its bid-ask spread prices. Using Figure 2 as a simple model, the biotechnology intermediary firm is able to adjust both its buy and sell prices in response to changes in supply or demand. For example, the firm may observe a rise in demand that shifts the demand curve to the right. In response to such rise in its demand, the firm increases the sell price to ration demand and raises the buy price to encourage supply. In this way, the biotechnology intermediary firm can adjust prices so that the market-clearing condition is met at a higher level of output. The biotech intermediary firm provides immediacy by holding inventories and cash through adjusting prices. For example, it might choose to reduce inventories either by decreasing the ask price below the level shown in Figure 2; thus increasing consumer demand, or by raising the bid price, which leads to bring additional supplies. By implementing such policy, the biotechnology intermediary firm varies its bid and ask prices, which in turn, depends on its inventory levels that is observed after its demand and supply are realized.

4. Intermediary firms and market structure

Although economic theories provide a series of approaches to analyze the theory of firm, they have not discussed a situation in which both firms and market allocation within the same framework is addressed. Nevertheless, economists indentify four major pillars in microeconomic theories on the grounds of aggregation levels. These four classifications are (*i*) neoclassical, (*ii*) industrial organization, (*iii*) contractual or transaction cost, and (*iv*) organizational-incentive or principal-agent (Spulber 1999). The first group aggregate market models across the entire economy assuming the size of each firm is relatively small with respect to the market implying each entity is price-taker. The second group, unlike the first one, emphasizes on the industry and recognizes the market power of individual firms. The third group focuses on transaction cost as a unit of analysis on the firm's relationships with trading partners. Finally, the last group discusses hierarchical relationships within an individual firm. There is a discrepancy amongst the aforementioned theories between the functioning of firms in the market from an institutional perspective. Neoclassical economics stresses the role of the firm as operator of technology.

Industrial-organization models emphasize market power and strategic interaction. Contractual theories of the firm focus on choosing the boundaries of the firm where market transaction costs exceed the costs of organization. Organizational-incentive theories of the firm stress delegation within hierarchies. One advantage of the intermediary theory of the firm is that it encompasses all the elements of the above four theories. In particular, this theory retains the input-output approach of neoclassical theory and presumes competitive price setting by firms as in industrial organization. Moreover, the intermediary theory of the firm addresses transaction costs and opportunism as in contractual theories of the firm and incorporates principal-agent relationships both within the firm and between the firm and its suppliers and customers. In total, intermediation models posit that the firm is a market maker, coordinating the actions of its customers and suppliers. The level of aggregation in intermediation models is narrower than that of neoclassical models, which looks across markets. This level of aggregation is broader than that of industrial organization because it incorporates both the firm's input and output markets. The focus is considerably broader than contractual theories of the firm since intermediation theory attempts to examine the full set of the transactions carried out by the organization. Intermediation theory addresses organizational issues by noting that the firm delegates intermediation to managers, employees, and suppliers. The intermediation theory of firms and markets provides an answer to the question of who decides. In this theory, firms' managers involve in a wide range of decision-making activities, which means searching for trading partners, selecting prices, managing customer and supplier relationships, and identifying new opportunities for establishing and operating markets. Following the fundamental neoclassical framework, firms acting as intermediaries coordinate input purchasing, production and supply decisions, recognizing the connections between prices in input and output markets. As in industrial-organization models, intermediaries act as competing price makers. Following transaction-cost models, those firms that are operating as intermediaries earn returns from reduction of transaction costs, thus lowering the costs of using markets for their customers and suppliers by carrying out market-making activities. Finally, in accordance to the organizational-incentive models those firms which are acting as intermediaries reduce contracting costs by carrying out delegated bargaining and monitoring activities.

5. Intermediation as opposed to decentralized trade

Biotechnology companies engage in market making by setting prices, allocating goods and services, and holding inventories to coordinate transactions. Intermediation provides an endogenous mechanism for price setting that coordinates the activities of buyers and sellers. Meanwhile, livestock biotechnological intermediary firms will need to choose two sets of prices: ask prices for consumers and bid prices for suppliers. The bid-ask spread provides an alternative perspective on the economic profit of firms. Economic profit reflects the returns to the market-making activities of firms. A question might be raised and that is if livestock biotech companies are able to find customers to buy their products, why would the markets require intermediary firms to avoid decentralizing trade? The answer can be found by examining the role of intermediary firms. Intermediaries compete with direct exchange to absorb buyers and sellers. Consumers and suppliers choose between seeking each other out and bargaining over the terms of trade and exchange with intermediaries. In this situation, consumers and suppliers will definitely incur costs of searching and bargaining under decentralized trade, so that the existence of intermediary firms will be economically viable provided that they manage to lower their transaction costs. Precedent studies have addressed several models presenting a picture of markets as decentralized mechanisms with pairwise meetings of agents (e.g., Blouin and Serrano 2001, Gehrig 1993, Polanski and Vega-Redondo 2013, Serrano 2002). Such studies showed that these models contribute an understanding of the micro-mechanisms of price formation and their role in shaping market outcomes. In contrast, intermediated markets are more centralized because intermediaries deal with multiple buyers and sellers. Intermediary firms as price-makers provide an explicit mechanism of price adjustment that differs from pairwise bargaining. For instance, Gehrig (1993) proposed a model that analyzed competition between an intermediary and a decentralized matching market that is of interest in the agricultural biotech markets. In a decentralized market buyers and sellers engage in a procedure known as first-and-final offer bargaining. In contrast, in a centralized market the intermediary would choose a price spread that depends on the efficiency of searching and bargaining in the matching market. At the equilibrium price spread, high-willingness-to-pay buyers and low-opportunity-cost sellers trade with the intermediary firm. These are known as the early adopters. At this point, buyers who have a moderate willingness to pay and sellers who have moderate opportunity costs enter the matching market. Interested readers can find more information about the suggested model including propositions, corollaries, and proofs in Gehrig (1993).

6. Conclusion

The livestock industry faces a significant challenge from the introduction of biotechnologically modified inputs and outputs. If the biotechnology industry or the livestock sector does not find someone to intermediate the market, it faces the same fate as the crop sector. Wherever public regulators are weak, markets for these new credence-like products may not be forthcoming, leading to fragmentation. The theory of intermediation suggests that without intermediation there is the possibility that the entire market might not be realized, which would seriously impede adoption of the new technologies. As a result, innovators would face lower rates of return and would respond with lower research and development, which would translate over time into lost consumer and producer benefits. Furthermore, given the difficulty in segregating GM from non-GM production, existing livestock producers could face higher marketing costs from the unmediated introduction of new GM livestock products. This paper is obviously a preliminary application of the market microstructure theory of the firm. The theory needs to be applied more concretely to a variety of markets involving both GM and non-GM products to determine its general applicability. On the face of it, however, this study offers a refreshingly new and potential useful framework for analyzing markets in the making.

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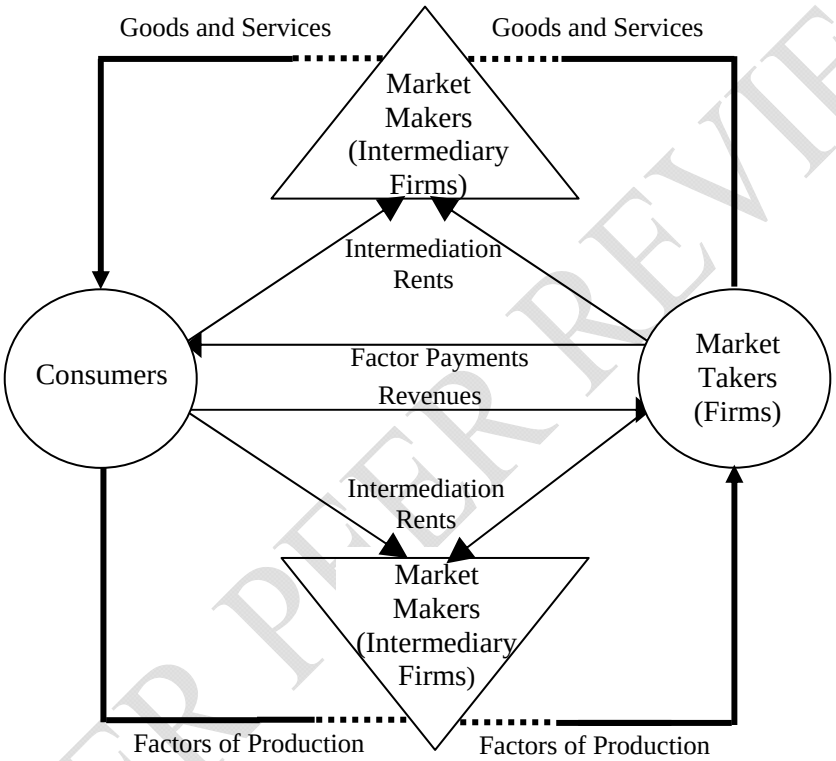
Figure 1. The roles of intermediaries in a circular flow of an economic activity



Source: Adapted from Spulber (1999).

Figure 2. The bid-ask price model