Farming For Profits in the Prince Edward Island Market for Processing Potatoes:
A Lerner Index of Market Power for the Buyer in Agricultural Markets

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Abstract

This research paper presents a model of the Prince Edward Island market for processing potatoes and constructs a nonparametric model of market power, based on that of Love and Shumway (1994), which provides a measure of market power similar to the Lerner Index. Although no data was available, and thus no results generated, the paper develops a case for concern with regards to the existence of market power exertion on behalf of processors on producers. Salient features of the market are discussed in detail in order to further understand what exogenous and endogenous factors may be contributing to market power.

Section 1
Introduction and Motivation

Potato production has undergone drastic changes over the last few decades. Consumer preferences have changed, consumers now demand quick, easy to prepare food solutions. As a result, fresh potato consumption has been overshadowed by processed potato consumption. Producers no longer produce a commodity slated for sale mainly on the fresh market; they have switched production towards the output of processing potatoes. In effect, market structure has changed from small family owned establishments with ties to the domestic market to large corporation, which operate on an international scale.

For example, the current market on Prince Edward Island is composed of 2 large processors and approximately 600 producers. Current acreage allocated to potato production is about 100,000 acres a year, with almost 50% of this assigned to processing[1]. This is a distinct contrast from the 1960's, when there were 6500 producers, and the 1980's when acreage was in the vicinity of 65,000[2].

The introduction of processing firms into the Prince Edward Island market has caused every facet of the industry to undergo changes to accommodate evolving consumer demands. No longer are Prince Edward Island potatoes shipped to over 20 countries in vast quantities. Now, the majority of potatoes never travel more than 100 km. Gould (1999) notes that french fry demand has long been the fastest growing and most substantial segment of the processed potato industry (Gould 1999 p.105). In response to the substantial growth producers and processors now utilize production contracts to secure demand and supply in what has become a very competitive, highly specialized industry. Moreover, production contracts have been shown to increase efficiency and streamline negotiations when the number and size of firms involved is large.

This research program seeks to explore the salient features of the Prince Edward Island market for processing potatoes in detail. It presents a nonparametric model, based on work by Love and Shumway (1994) and Raper and Love (1998), to examine the potential for rent-seeking behaviour on behalf of processors.

Section 2 of this paper introduces the Prince Edward Island processed potato industry more formally, paying attention to the unique geographical and structural characteristics. Changes in the international processed potato industry are discussed and relevant technological advances are noted. Also included here is a section on contracting and specific details regarding production contracts on Prince Edward Island. Section 3 builds the theoretical background for work that is being done in agricultural markets. The requirements for the existence of market power in agricultural markets are introduced and related to the Prince Edward Island market for processing potatoes. Special attention is paid to the structure of the market and the elasticity of supply. Issues of producer welfare, price risk, asymmetries of information, the role of production contracts, quality ratcheting, firm

[1] PEI Census Information http://www.gov.pe.ca/photos/original/af_stats01_tab1.pdf

[2] The Potato: Then and Now. Online Source. http://collections.ic.gc.ca/potato/history/20thPEI.asp

coordination, and demand uncertainty are explored in more detail. Section 4 contains a review of relevant literature. Section 5 presents the econometric model. Section 6 examines the role of production contracts in entry deterrence and increasing market power. Section 7 concludes and discusses future direction for this research program.

Section 2
Potato Processing

Unique Characteristics and Notable Changes

Prince Edward Island is especially suited potato production since the soil and climate conditions lend themselves to a uniquely flavoured product. Red soil with high nutrients content, water and air temperatures suited for potato production, and long winters that naturally cleanse the soil all play an integral part in assuring a high quality product. Potatoes are Prince Edward Island's largest crop and make up almost one-third of all farm receipts. The geographical size of the island, only 5,660 km^2, limits total annual production of potatoes and future expansion of the market for both table stock and processing potatoes.

Since the 1987 report by the Royal Commission the Island markets for processing and table stock potatoes have undergone drastic changes. Prince Edward Island was once an area that mainly served the fresh produce market, however, it now sees an almost equal share of processing and table stock/seed potatoes. This trend can be certainly attributed to changing consumer preferences. Not long ago potatoes were primarily considered a commodity to be consumed fresh, boiled, mashed, or baked. Consumer preferences, currently oriented towards fast, easy to prepare goods, has changed potatoes' primary use from a fresh commodity to a processed, easy to prepare good (Royal Commission 1987).

Fast food spurred much of the demand since the 1950's and accounts for the vast majority of french fry demand. North American demand for frozen french fries rose steadily from 1976 to 1994, while 1996 marked the slowest growth for potato products in the US in a decade. New, health conscious consumers have altered their preferences and substituted away from french fries, to healthier options such as salads. Experts expect no further growth in the demand for french fries beyond that of population growth. In effect, the demand for french fries and most frozen potato products has reached its saturation point in North America (Michigan State University 1997).

North American plants, particularly in Prince Edward Island and North Dakota, have been increasing capacities to meet increasing demand in Europe. It is suspected that North American plants are running at approximately 70-80% of maximum operating capacities and there is room for additional production. Canadian plants hold 14% of North American capacity. McCain and Irving have 23.9% and 3.7% of capacity in North America respectively (Michigan State University 1997).

Changes in consumer preferences and output have not been the sole notable change since the report by the Royal Commission. Technological innovations have played a major role in altering the production of processed potato products. The two most prominent process changes have been Machine Vision and Flavour Coating. Machine vision is capable of identifying bruises and automatically removing them. It is estimated that Machine Vision can minimize waste and cut labour and raw product handling by as much as two-thirds over the No Machine Vision alternative. Flavour

Coating has also recently appeared as a favourable approach at maintaining freshness and ameliorating taste. Flavouring technology can be very costly and only a select few plants have invested in the technology. As such, large chains such as MacDonald's cannot obtain a sufficient, trustworthy supply of product. It is believed that market share will go to the plants with new technology since they are capable of offering a lower cost good that is more preferred by consumers. Cutting and quick freezing processes have remain rather constant over the past twenty years, and there are no expectations for new methods in the near future (Michigan State University 1997).

Contracting

Since the report by the Royal Commission (Royal Commission 1987), the processed potato industry on Prince Edward Island has more than doubled, and become one of the most important sectors in the potato farming industry. A number of factors can be attributed to this change: changing consumer preferences, geographical disadvantage for P.E.I. farmers, ameliorated technology, and trend towards contracts for risk mitigation. These issues will be discussed in further detail in the following sections.

The processed potato industry, much like other agricultural markets, is highly vertically integrated through the use of production contracts and acquisitions along the production chain. Wilbur Gould notes that "Contracting is a basic requirement for success in the [processed potato] industry" (Gould 1999 p.106). Contracts are used for a number of reasons. Producers are thought to enter into contracts in order to better manage product demand fluctuations and price risk, acquire income stability, and information sharing. Processors are believed to offer contracts to secure inputs for their production, to stabilize prices, and to provide some intermediate level of control over producer activities.

Curtis and McCluskey (2003) suggest instead a number of alternative incentive schedules for processors and develop a two period model to test their hypothesis. For instance, the authors maintain that processors offer contracts to growers in order to improve the quality of the raw product and provide themselves with input supply control, quality control, improved responses to consumer demand, operational efficiency, and reduced contract costs due to decreased raw material searches, and improved negotiation position.

The fact that processors may strengthen their negotiating position by using production contracts for the producers could lead to anti-competitive behavior and a loss of independence in decision making if certain market characteristics are in place. Some industry members have noted that farmers are losing autonomous decision making ability and becoming employees of larger processing firms.

Market characteristics in the processed potato industry seem to be rather homogenous across North America as many of the qualities of the Prince Edward Island market are also observed in the Columbia Basin (Washington) of the United States. Both regions are styled after textbook oligopsonies with few buyers that all maintain the majority of the market share and many small sellers who to sell to these buyers. Curtis and McCluskey (2003) note that production contracts are used in the Columbia Basin to fight market thinness, maintain quality control, as well as to solve input timing and capacity issues. Intuitively, one can see how processors might benefit more from contracts than would growers, especially if they have ability to exert some market power. There is a possibility however that production contracts do benefit growers equally. Curtis and McCluskey discuss a number of papers that find production contracts can shift price risk from growers to intermediaries by 53-97%.[3]

Thus, contracts are a prominent issue in the processed potato industry and it is evident that contracts offer incentives to induce production of higher quality products. Problems begin when processors use market power to ratchet up the quality of the product, and place constraints on growers, without compensating them accordingly. This paper develops a model to measure the potential for market power exertion on behalf of processors.

Production contracts on Prince Edward Island are drawn up before the growing season and representatives from both the processors and the growers must agree on the terms of the contract before it can be finalized. The Prince Edward Island Potato Board serves to facilitate the negotiations between the two parties.

Production contracts are composed of two major sections; (1) Grower delivery and payment schedules; and (2) terms and conditions. The first section divides the growing/delivery season into periods and assigns a base pay rate to each period. The second section of the contract outlines the terms and conditions of the contract and includes items such as delivery conditions, storage, load acceptance criteria and payment adjustments, breach of contract rights, and information rights of the processor [4].

Contracted potatoes are subject to the generic productions contract and any additional stipulations declared by the processor. Base prices are agreed upon by all parties and reflect market expectations. Even so, the final price paid for a load is dependent on the quality of the load and is a subjective measure made by employees of the processing firm. Processors have the right to inspect farm operations at anytime time and can specify the type or fertilizer, top kill, and other chemicals to be used by the grower. These conditions may lead to unequal distributions of bargaining power between growers and processors as processors have the ability to specify certain conditions that could increase processor market power, i.e., specification of processor owned chemicals and/or credit obligations as is discussed in Section 3.

Section 3
Theoretical Background

This section introduces the requirements for the existence of market power in buyer side agricultural markets as defined by Rogers and Sexton (1994). These requirements are then compared to the Prince Edward Island market for processing potatoes in order to determine the likelihood that there exists market power. Considerable attention is paid to market structure and elasticity of supply. Issues of producer welfare, price risk, asymmetries of information, the role of production contracts, quality ratcheting, firm coordination, and demand uncertainty are explored and applied to the processed potato industry.

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[3] See Curtis and McCluskey (2003) for a more detailed discussion regarding risk shifting.

[4] Contract courtesy of Maritime Potato Inc. and available upon request.

Requirements for the existence of market power

Although buyer side market power may not exist in many of the generic input markets, labor, capital, and energy, we may be witnessing monopsony power in more specialized input markets, namely, first-handler markets for raw agricultural products that are purchased as inputs and are transformed into commodities.

Rogers and Sexton (1994) identified four criteria for the existence of market power in agricultural markets. They are as follows:

1: Bulky and perishable products with high shipping costs leading to restrictions on geographical mobility, and limited access to buyers.

2: Processor and buyer needs are highly specialized, other inputs cannot be readily substituted into the production process.

3: Extensive investment in sunk assets and highly specialized production processes cause for exit barriers and inelastic supply of raw product.

4:Marketing associations and seller co-operatives may be present, suggesting potential for bilateral monopolies.

Characteristics 1 and 2 indicate that markets for raw agricultural products are generally narrower than regular input markets, as such, there is potential for buyer concentration. Moreover, 1 and 2, coupled with 3 extend the distinct possibility for market power exertion on behalf of buyers in these markets. Since many agricultural markets for raw product meet these three criteria the presence of market power in agricultural markets may be more prominent than in other input markets. Further discussion on market power and the Prince Edward Island case will follow.

How PEI fits the Criteria

In order for there to exist the possibility of market power exertion by monopsonist two primary conditions must first be met: (1) the structure of the market lends itself to market power; (2) buyers must be facing a relatively inelastic supply from producers. This section will examine how well the Prince Edward Island processed potato market meets these criteria.

Prince Edward Island, on the Eastern Coast of Canada, is an especially interesting case because its geographical region is such that the only viable transportation to the mainland, until a decade ago, was by ferry or air. Yet, even with the introduction of the Confederation Bridge, Prince Edward Island potato producers are at a distinct geographical disadvantage, due to the nature of the raw product. Before the province's two main potato processors established themselves on the Island a vast majority of the product grown was exported by either vessel or transport truck. This was necessary as the raw product is very bulky and generally purchased and sold by the ton. The raw product, whether it be for table stock, or for processing, is subject to high transportation costs since it is very susceptible to spoilage, rotting, bruising and other quality depleting factors that can be attributed to exposure to light, changes in temperature and moisture. As such, the Island's two main processors chose to establish themselves in the province in order to minimize costs, and increase production efficiencies. A representative from Cavendish Farms stated that they receive the majority of their raw inputs from within a 30 km radius of the plant, further reenforcing the notion of high transportation costs and Prince Edward Island producers' geographical limitation to buyers[5]. Industry members in the US have claimed that any processing plant that must source its raw materials from over 240 km is at a distinct comparative disadvantage (Richards et al. 1994).

Examining the structure of the buyers' market reveals the potential for market power exertion as there are only two major buyers and a number of relatively small sellers. In addition to a textbook duopsony structure, additional characteristics for market power hold. For instance, the input required by the processors is very specialized; in effect, the product produced by the farmers must be tailored to the specifications of the processor (Some potatoes varieties commonly used for processing may not be as easily marketed on the table stock market and producers could find themselves with excess product that they are unable to sell to either market at a reasonable price). Processors require inputs that meet specific size, color consistencies, sugar concentrations, specific gravity, species, and quality (percent bruise free, scab free, etc) standards. Any deviation from these criteria can increase the time and cost required to produce the final output, as was discussion in the previous section. These additional costs are then transferred onto the supplying farmer by lowering the contract price through quality control.

The second major factor specifying a processor's ability to exert market power originates from farm supply elasticity attributes. There exists a large theoretical and empirical literature regarding price elasticity of supply in agriculture. In light of this, agricultural input markets being relatively inelastic in nature has become somewhat of a 'stylized fact'. The same case can be made for the Prince Edward Island potato industry as well.

Agricultural markets, for the most part, fit the specifications for price inelasticity of supply as set out by microeconomic theory because agricultural markets are very unique in several key areas. Examples of these include lack of spare capacity, stocks of product, easy of factor substitution, and time. These issues are discussed below.

Price inelasticity of supply is said to be likely when there is a lack of spare capacity in production. One could easily liken this to agricultural markets since agricultural markets require very specialized physical capital; harvesters, specialized trucks, specific chemicals, storage facilities, etc. to operate. Also, a farm's production capacities are limited to the physical capital on hand, in addition to land. Land, or acreage, is possibly the most limiting factor for Prince Edward Island growers as acres planted is confined to the opportunity cost of planting another acre, and since the Island is severely limited in space, the opportunity cost of land is likely to be high. Producers seeking to exit the market would ideally calculate present income streams to compare the present value of continuing production versus a one-time land sell out, or the present value of renting their land for other uses.[6] Ideally, farmers would choose the option that yielded the highest present value.

Stocks of product can also play a role in determining the price elasticity of supply for a good. Potatoes, much like other raw agricultural products, have limited shelf lives as they must be stored

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[5] From an interview by the Royal Commission conducted in 1987.
Royal Commission (1987) Report of the Royal Commission on the Prince Edward Island Potato Industry. Queen's Printer, November 1987. p. 190

[6] An interesting line of research could be to estimate the changing opportunity cost of planting crops on Prince Edward Island and compare this to the change in output price.

in extremely controlled conditions. Light, moisture, temperature, and humidity must all be regulated, and as time passes, potatoes shrink, greatly reducing their usefulness in processing. As such, raw product cannot be stored for extended periods of time, and once stocks are exhausted, producers cannot easily adjust supply to changes in demand and prices.

Elasticity would increase over time, from one year to another for instance, if contracts were not present. Farmers could potentially adjust supply from one season to another by planting fewer or more acres. In this case supply may be more elastic. However, we will see that production contracts often carry over from one year to another, either implicitly or explicitly. As a result, farmers may not have the necessary discretion to adjust their supply as they see fit, thus, supply elasticity may decrease with the use of production contracts.

Ease of factor substitution will also play a role in determining the supply price elasticity of a product. Potato production requires, labor, tangible capital, and land. Farm labor is, for the most part, easily substitutable across the industry, that is, a farm hand can generally perform a number of different tasks and may be equally useful in various farming operations. Tangible capital and land extend a far greater challenge, however. The production of potatoes requires, as previously noted, very specialized capital. A typical farm has not only the generic tractor, but a number of accessories and supplementary equipment as well. Planters, harvesters, windrowers, set cutters, fertilizers and sprayers, not to mention the specialized grading, washing, and packing equipment that some of the larger farms have. Much of this equipment is constructed for the purpose of growing potatoes, and its resale value outside of the industry is limited to the value of scrap recycling.

Finally, time plays a considerable role in supply elasticity in agricultural markets. If one considers the production time of a crop of potatoes, which is generally measured in months, production is slow by commodity market standards. Supply elasticity may tend towards inelastic as a result. Consider the time in planting and harvesting relative to the entire growing process. Planting and harvesting take up a mere few weeks and require almost ‘round the clock operation to ensure that all crops are planted and harvested within the allocated time. Few decisions can be made in this short time frame, thus, firms have little time to react to changes in demand and prices, further rendering the price elasticity of supply to be inelastic.

It is commonly accepted in the literature that agricultural markets for raw products face an inelastic supply curve and the Prince Edward Island market for processed potatoes is no different. The specialized inputs, high sunk investments, land and time constraints make for what is accepted to be a relatively inelastic supply curve. This fact, coupled with the structure of the market, would suggest that potato processors have the adequate conditions to exert monopsony power.

Welfare Concerns

This section will discuss possible welfare effects on farmers exclusively, as the scope of this paper is geared towards estimating market power exerted by processors on farmers. Nevertheless, it should be noted that there exists a vast literature concerning the impact of market concentration on all links in the food chain, one example of such work is Piggott, Griffith, and Nightingale (2000).

Since 1996 as much as, or more than, 50 percent of potatoes grown on Prince Edward Island has been allocated to processing, the majority of these having been contracted prior to the planting season (PEI Potato Marketing Board). The processed potato industry is one of Prince Edward Island’s largest and most important sectors. It employs thousands of people in processing plants and on farms, not to mention the countless laborers in associated industries such as trucking, retailing, marketing, fertilizer, and equipment fabrication. Even so, concentration and growth in the processing sector may be cause for concern when small farmers' welfare is considered. There is no doubt that contracts play a major role in the current operation of the system. As a result, this section will attempt to examine the potential welfare altering features of such production contracts.

Price Risk

Producers who choose to enter into production contracts with processors ultimately give up the option to sell those contracted potatoes on the spot market should a higher spot price prevail (assuming the cost of defaulting on contracts is high, or default is not possible). What is of specific interest are welfare altering aspects of production contracts that arise from market power and unequal bargaining ability. This type of rent extraction is of interest and will be discussed in the remainder of this section.

Asymmetric Information

If processors have unequal bargaining power, they are potentially capable of using their discretion, and asymmetric information, to enter into unjust contractual agreements with growers. For instance, processors are free to offer contracts to whomever they see fit. If a processor is unhappy with a grower for, suppose, attempting to organize a growers co-op, the processor is free to withhold a contract from the grower in subsequent seasons, threatening the grower's financial integrity.

Likewise, some growers report cases of unforseen investment requirements in order to secure a contract with a particular processor. Processors may require growers to use certain fertilizers and machinery - brands which are generally owned by the processor - thereby limiting the grower's free choice. Some processors issue debt to farmers, or lease equipment and require payment in-kind, and, since one growing season will not habitually cover the costs of the debt, growers are 'locked-into' several consecutive contracts with a processor. Processors may subsequently be able to adjust future contracts to extract more surplus and reduce grower's rents from land, or 'grade hard' (an issue that will be further discussed below) in order to reduce contract price and keep debt payments high (Glover and Kusterer 1990).

Discretionary power may result in some growers being left without a contract year after year, causing them to ultimately leave the processing market. It is believed that processors prefer larger growers, as they are able to supply more raw product on one contract than smaller growers, thereby increasing operational efficiency and lowering contracting costs. This type of market pressure could force the growing sector to become more concentrated through mergers and acquisitions, leaving smaller farmers with no choice but to exit the industry. Although this may be acceptable by efficiency standards, it does not account for welfare, income, and equality arguments that are often raised by growers and their supporters (Glover and Kusterer 1990).

Production Contracts

The very nature of potato production contracts on Prince Edward Island may enable processors to gain an unfair bargaining advantage over growers simply because they give processors the right to inspect virtually every aspect of potato production, leaving growers with no ability to conceal information. While it is argued that processors maintain the right to examine production in order to detect bad practices and limit potential losses, this right may in reality be much more valuable to the processor. By inspecting grower practices at will, processors are able to accumulate a wealth of information regarding every grower they deal with. Consequently there no doubt exists some asymmetric information that could potentially damage the bargaining position of growers.

Consider the grading process. Potatoes delivered to processors are subject to a grading scheme that determines the final price paid to the grower. This grading is done by employees of the processing firm and growers are rarely present when the actual grading is performed. As such, it is possible that certain deliveries could be 'graded hard' to lower the final price, especially when spot prices (the processing firm's alternative supply) are high. Note that growers do have the right to have potatoes graded by an impartial third party government inspector. Yet, this is a cost to the grower and could potentially cause processors to use their discretionary powers (as discussed above) in future contracting periods. In effect, growers may be subjected to 'grading hard' and left with no welfare improving alternative, or simply may be unaware of the issue at all. There have been a few accusations of this in New Brunswick, although farmers are fearful of making public accusations for fear of repercussion by processors[7]. One potential remedy of this problem could see a market for third party inspectors introduced, if demand is thought to be high enough to sustain supply. In any event, regulating bodies would have to be certain that the larger, more powerful processors do not influence the inspectors and further increase their market power.

Production contracts could also lead to unfair 'tournament style pricing', where processors grade and price potatoes relative to other growers' deliveries, thereby lowering the price of the lowest quality growers below the actual market value of the delivery. While this type of practice may harm lower quality producers, it may also benefit the 'highest' quality producers by making their product seem 'relatively' better in quality than other growers' and result in easy grading or future contract benefits. Tournament style pricing mainly serves to protect the processor from shirking growers. Growers that claim poor quality due to weather conditions can be compared to other growers facing the same conditions and handled accordingly, thereby lowering the risk of shirking for the processor (Glover and Kusterer 1990).

<u>Ratcheting</u>

Another potential result of asymmetric information is ratcheting. Since processors are capable of accumulating information regarding each grower, they have the ability to draw conclusions pertaining to relative performance and abilities. For example, by gathering information about production practices, inputs, outputs, and other variable, processors gauge a grower's potential ability and monitor it from period to period. Processors may request a higher quality output in the next period from certain growers because they believe that the grower has the 'ability' to produce a better product. This type of behavior is called ratcheting and has been tested for in the processed potato industry by Curtis and McCluskey (2003). They provide a detailed discussion of ratcheting and construct a model to measure the extent that this occurs incertain markets. They find evidence of ratcheting in the Columbia Basin market for processed potatoes. This type of behavior is not necessarily bad for the market, as it compels growers to produce a higher quality product and improve production techniques. Problematic issues arise when processors ratchet up the quality, but do not adequately compensate the growers, thereby receiving a higher quality product for no additional cost - an effective method for extracting rents from growers.

<u>Coordination</u>

Some work has also been performed on the link between contracts and coordination, namely,

[7] http://www.choicesmagazine.org/archives/2003/q1/2003-1-05.htm

the facilitation of oligopsony coordination through production contracts[8]. Duopsony structures within a spatial markets model are generated to demonstrate that exclusive production contracts can diminish competition between buyers and enhance oligopsony power through buyer coordination. Thus, if buyers have some market power, and can utilize captive supply contracts to enhance this power, growers may be increasingly at the mercy of processors with oligopsony power. This line of research, although very new, may have important implications for agricultural policy analysis in the near future.

Demand Uncertainty

A final concern for farmers may result from demand uncertainty, another market characteristic that can be affected by asymmetric information. As in any other market, equilibrium arises when perceived supply and demand are equated, and the good is sold at the resulting market price. Processors and farmers alike are able to attain crop yield information from other growers in the market relatively easily, and consequently can determine supply of processing potatoes with some degree of accuracy. Demand, on the other hand, is not so easily ascertained. Not only do farmers lack information regarding processor output requirements, they also lack precise information regarding processor grown raw input. In effect, growers are uncertain as to the raw input requirements of the processor outside of their own raw input production. Processors may then have the ability to offer 'take-it or leave-it' prices, stating that they can meet the requirement from their own stock if growers refuse the price, growers never being certain of the validity of such statements must take poorly calculated risks (Glover and Kusterer 1990).

Section 4
Review of Market Power Literature

Studies of economic structure and performance have changed dramatically over the past half century. One area of particular interest to economists has always been industry structure and firm conduct - market power and its extensions has often been at the heart of Industrial Organization (IO hereafter) literature. There exist two mainstream types of market power literatures, the structure-conduct-performance paradigm (SCPP) and the New Empirical Industrial Organization (NEIO). In the early 1950's Bain (1951) started what would be a twenty-five year exploration of market power by implementing the SCPP. This type of study presupposed a one-way relationship from market structure to conduct to performance (Sheldon and Sperling 2001). Sheldon and Sperling (2001) have produced an extensive list of both SCPP and NEIO publications that have helped to shape today's mainstream market power literature.

SCPP style work assumed that accounting information would reveal the cost information necessary to infer market power in a large number of disparate industries (Sheldon and Sperling 2001). Bain conducted the pioneering work in the area which continued into the mid 1970's. Soon thereafter, a new thread of IO literature began to criticize the SCPP methodology on various levels. Oftentimes these criticisms were directed to the inference that marginal costs could be observed from readily available accounting data. This deduction was shown to be flawed and dissatisfaction grew

[8] For an example of this see Albaek, Sven., Mollgaard, Peter., and Overgaard, Per B. (1997) "Government-Assisted Oligopoly Coordination. A Concrete Case," *Journal of Industrial Economic*, Vol. 45:4. pp. 429-443.

as a result of the following criteria: (i) is was not likely that economic price-cost margins (performance) could be directly observed in accounting data, (ii) cross-section variation in industry structure could not be captured by a small number of observable measures, and (iii) empirical work should be aimed at estimating the reduced-form relationship between structure and performance (Bresanhan 1989).

Shortly thereafter a new market power literature began to emerge, the NEIO, New Empirical Industrial Organization. More direct estimations of marginal costs began to emerge, most notably from Gollop and Roberts (1979), and Appelbaum (1979, 1982). Appelbaum (1982) and Bresnahan (1982) were two of the first major contributors in this field. They offered production theoretic, and general identification methods to estimating market power. Bresnahan (1989) outlines the gradual establishing of the NEIO method and the models currently used in most of the market power literature.

Since the early years of the SCPP the bulk of the literature has been concerned with seller-side market power, as it appears to be the most common in industrial organization. This paper however, will deal exclusively with buyer-side market power, a form of market power seldom studied in modern markets.

Much of the currently available literature concerning agrifood-type industries is centered around the beef packing industry, with a few references to the pork, broiler, and tomato markets. More specifically, the early to mid-1990's produced a string of publications on the beef packing industry in the US, mainly by Azzam.

In 1997, Azzam sought to measure market power and cost efficiency of concentration in the American beef packing industry using Appelbaum's (1979, 1982) framework for price taking behavior. The paper demonstrates that there may exist some market power in the beef packing industry as the null hypothesis of price taking behavior is rejected. Nevertheless it was deemed that the cost efficiencies outweighed the negative externalities of the market power. The author does note that aggregation of the time series data may have affected the results somewhat and that panel data would have been more appropriate in this application, however.

Azzam (1998) analyzed the usefulness of market power tests in the meat packing industry across time. Azzam compares how competition looks under two separate lenses. Firstly, how competition looks under the economic lens as assumed by many economists, and secondly how the market has been structured over the course of its 300 year history. The paper concludes that mainstream economic studies are best suited to aid in competition policy targeting conduct, not structure. The paper offers the most extensive literature review on market power in the meat packing industry to date.

Crook et al. (2002) addressed the common problem concerning most market power studies, namely, the lack of cost and MVP data. Since cost data is very seldom released, there exists some uncertainty regarding the accuracy of estimation of MVP, and subsequently, the degree of market power. Crook et al. attempt to measure market power with variables other than price. The authors develop a method of testing market power based on the degree of exclusivity of supply of cattle to packers. Since supply of cattle is based on demand by packers (and thus exogenous demand in the finished goods market), the exclusivity of the supply may indicate the degree of price setting ability for the packers. This paper relies heavily on captive supply and contracting theories. The data used in the model was obtained from the USDA and is treated as confidential. As such, only aggregate data is presented in the article. The authors are quick to note that although market power was determined to exist, one can not be certain of the results until further studies are conducted. Since the data is so sensitive, it is unlikely that other data sets will be readily available in the future, hence limiting this type of market power testing.

Since so much work had been conducted on the beef packing industry Vukina and Inoue (2003) chose to explore the potential for market power in the swine industry in the US. This study imposed more complexity than many of the beef studies since the data that exists for the swine industry is different, and more limited, than the beef industry. The authors developed an alternative test for market power. They proposed a method of estimating the elasticity of the inverse supply function for grower input using factor analysis. If the statistic turned out to be positive and significant, then there exists some degree of market power. Grower ability and effort is the common factor input used in this model, and the difference between the MVP of the common factor and the price paid is attributed to noncompetitive contracting practices. As is the case with many other studies based around unobservable statistics, this one is plagued by a number of issues. The most prominent however may be the effect of incomplete and asymmetric information in contracting in this market, the characteristics of which are similar to the processed potato industry. Being able to remove this error from the statistic to be estimated would potentially ameliorate the inaccuracy of the results.

Leegomonchai and Vukina (2003) developed a new approach to the estimation of market power. They began by assuming market power exertion by processors on broiler producers, and consequently tested for hold-up in the form of under-investment. A spatial model is used, and the hypothesis suggests that the number of processors in an area is positively correlated to the size of producer investment. Their results from American data, suggest that there is no correlation between concentration and investment. Nevertheless, this does not extinguish all likelihood of market power exertion: it may simply be that contracts and /or unobserved market characteristics are contributing to the lack of correlation, and that other statistics may prove more useful.

Gervais and Devadoss (2003) constructed a bilateral monopoly framework to test the bargaining power on both sides of the Canadian chicken producers and processors market. The study uses a dynamic quantity and price adjustment system to determine the price of live chickens, and as a result, the profits of both producer and processor. The results from the simulation are tested against actual market data and the authors fail to reject the null hypothesis of equal bargaining power. The most interesting facet of this study is its incorporation of producer cooperatives in the equation, something that is often prominent in actual agricultural markets, but is often left out of theoretical treatments. Also, since the Canadian chicken market is governed through supply management, if the model is correctly specified, discrete changes in regime (exogenous shocks) can be followed through the model and their implications can be observed.

Keeping with the exogenous shocks literature, Just and Chern (1980) published arguably the most influential paper using exogenous shocks to describe market power exertion in agricultural circles thus far. They used a frame work similar to that of Bresnahan (1982) by examining supply and demand elasticities and shifts after an observable shock. The authors used market data from before and after the introduction of mechanical harvesting to test for the existence of market power in the California processed tomato market. The introduction of mechanical harvesting was used since under competition it should affect only market supply. Also, mechanical harvesting was adopted across the market in a timely fashion, allowing the authors to assume a ‘discrete and complete’ shock to the system. The introduction of mechanical harvesting was found to be statistically significant in the substitution away from labor, a more variable input than mechanical processes. Using theories of competition and oligopsony power the authors were able to compare the observed elasticities and shift in supply and demand to the theoretical changes in either type of market structure. They concluded that the introduction of mechanical harvesting should have, and did, caused the supply of raw input to become more inelastic, due to increased fixed costs relative to variable costs. The supply also shifted to the right, as was expected. The most interesting events however, occurred in the demand markets. It was shown that in some counties demand elasticities fell, and raw input demand also fell. This fall in raw input demand by processors contradicts competition theory, and suggests anti-competitive behavior. In light of this evidence, the authors concluded that the null hypothesis of competition could be rejected with acceptable confidence in some counties. The results of this paper are especially interesting as they utilized exogenous shocks to determine market characteristics without making too many assumption about unobservable data, thereby establishing a strong argument for their results and paving the way for a new thread of applied oligopsony literature. The remainder of the papers are discussed below and in the following section.

In December of 1994 the American Journal of Agricultural Economics published a series of 4 articles dealing with the measurement of oligopsony power in agricultural markets, the first of which discussed the unique characteristics of agricultural markets that make them susceptible to market power on the buyer side.

Rogers and Sexton (1994) noted that oligopsony markets can no longer be referred to as the analogue of oligopoly because they retain their own individual characteristics that cannot be paralleled to oligopolies. Furthermore, contrary to current IO literature, oligopsonies are probable in markets that possess the necessary characteristics. Those characteristics being: (1) high shipping costs because of bulky/perishable goods; (2) highly specialized inputs and low degree of substitutability; (3) extensive investment in sunk assets for production; and (4) market power is possible through marketing cooperations and buyer concentration. This paper, along with the others included in the issue were a product of earlier agricultural-specific market power papers that began to surface in the late 1980's and early 1990's.

A new thread of literature that sought to estimate monopsony power began to emerge, including Hyde and Perloff (1994), Love and Shumway, (1994), Raper and Love (1998), and those already noted. Love and Shumway, and Raper and Love will be discussed in the following section.

Much of this literature rests on assumptions of profit maximization and cost minimization given technological change and specified production functions in which competitive firms equate price to MC. Hall (1988) serves as the backbone for this literature where the author constructs a model to compare price and MC, not by specifying demand schedules and assuming profit maximization, but by examining changes in cost.

The majority of the papers to date (published and working) rely on some form of parametric assumption about either the cost function or residual supply of the factor good. And while this is still the mainstream approach to testing for market power, there exists a small literature that is beginning to surface that involves a non-parametric approach to market power. This type of test will be the foundation for the work done in this paper and will be discussed further in following sections.

As is apparent, the current trend in literature is toward NEIO approaches that seek to estimate the degree of market power. Even so, there is room for additional areas of research to be launched. For instance, under the NEIO, what are the necessary and sufficient conditions for market power to exist, what role do barriers to entry and predation play, how do structure and conduct interact, and how effective are policies that seek to curb this power? Many of these topics are still being explored by IO economists.

Section 5
Econometric Model

To model monopsonistic behaviour in the Prince Edward Island processed potato market I extend a model developed by Love and Shumway (1994) in which nonparametric tests for market power exertion are used to consider monopsonistic behaviour in a simulated market. Love and Shumway address the often cited problem with NEIO tests for market power by constructing a model that makes no assumptions about the functional forms of cost or supply equations, work that was pioneered by Varian (1984). They begin by considering a generic NEIO model for market power estimation based on profit maximization and a conjectural variations coefficient that measures the degree of "below marginal value product" (or alternatively in the case of monopoly, above marginal cost) pricing (Bresnahan 1989). Taking this framework into account the authors fashioned a nonparametric test for market power that relies on discrete changes in inputs and prices to generate a market power parameter similar to the Lerner Index. Upon running simulated data the authors note that the model generally did well to measure market power under competition, monopsony, and different oligopoly setups. There were a few outliers and false indications, however, the severity of these exceptions seemed to be conditional on the choice of functional weights.

Raper and Love (1998) also used the original model by Love and Shumway to estimate market power exertion in the US cigarette tobacco industry. Market characteristics of tobacco, in production and processing, are highly specialized and comparable to the processed potato industry. The authors used the non-parametric discrete changes framework to test for evidence of market power exertion in the domestic tobacco market alone, and the domestic and import markets simultaneously. The results from the data suggest significant departure from MVP the in the domestic market for raw tobacco inputs. There did not seem to be any evidence suggesting market power exertion in world markets. This paper was especially valuable since it applied the theoretical framework presented by Love and Shumway to a market with similar characteristics to the market that this paper is attempting to explore. The following section will introduce the framework presented by Love and Shumway, explain its components, and apply it to the Prince Edward Island processed potato market.

Consider firm i's profit maximizing problem

$$\max_{yi,xi,xni} \pi_i = py_i - C_i\left(y_i, r; x_{ni}\right) - r_n\left(x_{ni} - x_{ni-}\right)x_{ni} \tag{1}$$

Where

π_i; firm i's profit

p; output price

y_i ; firm i's output quantity

r ; vector of variable input prices excluding r_n

$r_n(x_{ni} + x_{ni-})$; price-dependant residual agricultural supply function

x_{ni} ; firm i's consumption of input n

x_{ni-} ; quantity of n demanded by all other firms

$$x_n = (x_{ni} + x_{ni-})$$

$C_i(y_i, r; x_{ni})$; firm i's cost function, which is assumed to be the same for all i.

The first right hand side term in equation (1) is firm i's revenue from the sale of output. The output, y_i, is dependant on the firm's production function, which will be assumed to be the same across the market, and the price p is determined by competitive and anti-competitive forces in the output market. The second term describes the firm's cost function, excluding the input for which the firm is thought to have market power. And the final term is the firm's endogenously determined input cost, in our case, the price of processing potatoes. Each processor's optimal input and output choice is given by their first order conditions, which can be derived as:

$$\frac{\partial \pi_i}{\partial y_i} = p - \frac{\partial C_i(\cdot)}{\partial y_i} = 0 \text{ where } \frac{\partial C_i(\cdot)}{\partial y_i} = MC \tag{2}$$

$$\frac{\partial \pi_i}{\partial x_i} = -\frac{\partial C_i(\cdot)}{\partial x_i} - \frac{\partial r_n(\cdot)}{\partial x_n}\left(1 + \frac{\partial x_{ni-}}{\partial x_{ni}}\right)x_{ni} - r_n = 0 \tag{3}$$

Equation (2) yields firm i's supply function conditional on input x_{ni} since firm i's marginal cost is a function of the level of agricultural input chosen. As such, even though firms do not have market power in the output market their MC is a function of x_{ni}, which is affected by endogenous power.

From equation (3) one can use $\partial r_n(\cdot)/\partial x_n$ to determine how input price, r_n, is affected by changes in x_n, while $\partial x_{ni-}/\partial x_{ni}$ is the conjectural variations coefficient, i.e., a measure of how other firms' consumption of x_n is affected by x_{ni}. For an extensive discussion of conjectural variations coefficients see Bresnahan (1989).

For example, as in Love and Shumway, if:

$\frac{\partial x_{ni-}}{\partial x_{ni}}$ = 0 then (3) is the First Order Condition for a Cournot firm

$\frac{\partial x_{ni-}}{\partial x_{ni}}$ = -1 the (3) is the First Order Condition for Bertrand Competition

Perfect competition, as in Bertrand competition, would result in a conjectural variations coefficient of -1 since firms take other firms actions as given and are concerned only with profit maximization. In each case, the good in question is priced at its marginal value in production.

Profit maximization requires a firm to equate its marginal outlay, $\left(\partial r_n(\cdot)/\partial x_x\right)\left(1+\partial X_{ni-}/\partial x_{ni}\right)x_{ni}+r_n$, to its Marginal Cost, or Marginal Value in Production, $-\partial C_i(\cdot)/\partial x_{ni}$. Furthermore, equation (3) can be rewritten in such as way as to provide a convenient measure of market power. In other words, it can be shown that

$$L_i = \frac{\partial r_n(\cdot)}{\partial x_n}\left(1+\frac{\partial x_{ni-}}{\partial x_{ni}}\right)\frac{x_{ni}}{r_n} = \eta_{ni} \qquad (4)$$

where L_i is the 'Lerner Index' of market power and measures the degree to which firm *i* can lower input price of the agricultural input, potatoes, below MVP[9].

Now suppose one chose to take a non-parametric approach to market power estimation and that firm level price and production data are available. Equation (1) can be rewritten as:

$$\underset{yi,xi,xni}{Max}\ \pi_i = py_i - \sum_{k=1}^{n-1} r_k x_{ki} - r_n\left(x_{ni}-x_{ni-}\right)x_{ni} \quad \text{Subject to } F_i\left(x_i, x_{ni}\right) \geq y_i \qquad (5)$$

where r_k is the price of input k, and x_{ki} is quantity of k demanded by firm i. It is easy to see that the parametric assumption regarding the functional form of the cost function has been omitted and replaced with the summation of inputs and prices that are required for the production of output, less the agricultural input for which the firm may have market power. As before, a firm with monopsony market power in the n^{th} input market can influence input price, r_n, by its choice of input x_{ni}.

Now assume a discrete changes in input variables, profit maximization requires:

$$\Delta\pi_i = p\Delta y_i - \sum_{k=1}^{n-1} r_k \Delta x_{ki} - r_n \Delta x_{ni} - x_{ni}\Delta r_n \leq 0 \qquad (6)$$

[9] For original publication on the Lerner Index see: Lerner, A.P. (1934) "the Concept of Monopoly and the Measurement of Monopoly Power," *Review of Economic Studies*, Vol. 1. pp. 157-175.

The monopsony price markdown term is the right-hand-side term $x_{ni}\Delta r_n$ which measures by how reducing purchases of the input x_{ni} firm *i* can reduce the price, r_n it must pay for the input. Tests based on measuring market power exertion are based on measuring the empirical significance of this term (Raper and Love, 1998).

Alternatively, one could write (6) such that the discrete changes referred to time periods in the sample set T. In other words,

$$p^t\left(y_i^s - y_i^t\right) - \sum_{k=1}^{n-1} r_k^t\left(x_{ki}^s - x_{ki}^t\right) - r_n^t\left(x_{ni}^s - x_{ni}^t\right) - x_{ni}^s\left(r_n^s - r_n^t\right) \leq 0 \qquad \textbf{(7)}$$

where T is set of observations and $0 \leq t \leq T$.

If the firm is competitive in all markets then the last term in (7) disappears since the firm does not have the ability to alter prices of any inputs by changing quantities purchased or sold. In this case (7) becomes the weak axiom for profit maximization (WAPM) and creates the basis upon which non-parametric tests of price-taking and profit maximizing behaviour can be carried out (Varian, 1984).

Equation (7) does require two assumptions to be made, however;

i) input supply curves do not shift, and

ii) there is no general price inflation.

As mentioned by the authors, both (7) and WAPM require the existence of no technical change in the industry. In effect, all shifts in the demand for x_{ni} are presumed to be due to changes in exogenous prices of output and other, 'non-agricultural', inputs.

Recent empirical work with nonparametric tests for market power have imported other variables that may account for distortions in the results. These techniques were employed to address the 'no technological change' assumption which is unlikely to hold in practise. Love and Shumway, and Raper and Love have incorporated technological change in their nonparametric models based on the work done by Chavas and Cox (1990, 1994).

Technical change using an elemental approach can be considered as changes in output that are not attributed to changes in input. With this basic assumption, Chavas and Cox present a non-parametric analysis of technology, technological change, and productivity in the context of cost minimizing behaviour introduced by Varian (1984) which they called an "augmenting hypothesis" approach to technical change.

Chavas and Cox extend the Afriat-Varian methodology for introducing technological change to incorporate "netput augmentation"[10]. This method converts actual netputs into effective netputs. They maintain that, given a non-parametric representation of the effective technology, "netput augmentations" provide an adequate characterization of technological change. Technological change is introduced in the event that the underlying technology is not homogeneous across all time periods in T. In the presence of suspected technological change they distinguish between "actual netputs" $x_t = \left(x_{1t}, \ldots, x_{nt}\right)$ and "effective netputs" $X_t = \left(X_{1t}, \ldots, X_{nt}\right)$. Actual and effective netputs are then

[10] See also Afriat, S.N. (1972) "Efficiency Estimation of Production Functions," *International Economic Review*, Vol. 13. pp. 568-598. Also, a higher value of 'A' implies that producing the same effective netputs X can be produced with less of the input (from Chavas et al. 1994)

related through the following translating hypothesis relationship:

$$X_{it} = X\left(x_{it}, A_{it}\right), i \in N; t \in T \tag{8}$$

where X(x,.) is a one-to-one increasing function and A_{it} is a technology index associated with the *i*-th netput and the t-th observation. Intuitively, one an see how A_{it} can "augment" the actual quantities into effective quantities.

Similarly, one can redefine:

$$Y_i^t = \left(y_i^t - a_i^{t+} + a_i^{t-}\right) \tag{9}$$

where y_i^t is effective output and Y_i^t is observed output. Likewise, a_i^{t+} refers to a positive technological change, and a_i^{t-} a negative change (stochastic factors affecting production) and production functions are assumed to be strictly increasing and concave.

Moreover, all comparisons for which $r_n^s - r_n^t \overset{s}{\neq} x_{ni}^s - x_{ni}^t$, where $\overset{s}{\neq}$ means "not the same sign as", are omitted as in Love and Shumway (1994) and Raper and Love (1998) because shifts in the input supply curve that are not compensated for by corresponding shifts in input demand may cause movements in price and quantities in opposing directions. Intuitively one can see how these changes are not due to market power exertion and as such, they are omitted. In order to account of no general price inflation, data should be deflated to obtain real prices.

This particular model can be solved as a Linear Programming problem by finding whether there exists a set market power parameters, m_i^{ts}, and technological change measures, a_i^{t-}, a_i^{t+}, to solve:

$$\underset{a_i^{t-}, a_i^{t+}, m_i^{ts}}{Min} \sum_{t=1}^{T} \left(b^{t-} a_i^{t+} + b^{t-} a_i^{t-} + \sum_{s \neq t=1}^{T} c^{ts} m_i^{ts} \right) \tag{10}$$

Subject to:

$$p^t\left[\left(y_i^t - a_i^{t+} + a_i^{t-}\right) - \left(y_i^s - a_i^{t+} + a_i^{t-}\right)\right] - \sum_{k=1}^{n} r_k^t\left(x_{ki}^t - x_{ki}^s\right) - m_i^{ts}\left(x_{ni}^t - x_{ni}^s\right) \geq 0 \tag{11}$$

$$\forall s \neq t \text{ except when } r_n^s - r_n^t \overset{s}{\neq} x_{ni}^s - x_{ni}^t$$

ii) $a_i^{t+} \geq 0, \forall t \in T$

iii) $a_i^{t-} \geq 0, \forall t \in T$

iv) $m_i^{ts} \geq 0, \forall t \in T$ where $m_i^{ts} = \eta_{ni}^{ts} r_n^t$ and $\eta_{ni}^{ts} = \dfrac{MVP_{ni} - r_n}{r_n} = L_i$

if $\eta_{ni}^{ts} = 0$ then $MVP_{ni} = r_n$ and there is no evidence of market power exertion through prices.

if $\eta_{ni}^{ts} > 0$ then $MVP_{ni} > r_n$ and there is reason to believe that firm *i* is exerting market power.

The solution to this linear program will provide values for m_i^{ts} , and, as previously noted m_i^{ts}/r_n is the analogue to the Lerner Index, L_i. When $L_i > 0$ there is reason to believe that market power is being exerted. Nevertheless, we cannot determine what type of market power is being exerted. The 'original' Lerner Index, used to measure monopoly power produced values between 0 and 1. In effect, one could differentiate between perfect monopoly/collusion and some sort of oligopoly structure. The monopsony Lerner Index does not allow for such a simple comparison as MVP is greater than the cost of the input if market power is being exerted. As such, possible values for L_i range from 0 to some upper bound γ_i, assuming profit maximizing behaviour. In order to properly compare outcomes the upper bound, γ_i, must be estimated[11].

In order to obtain an upper bound suppose we have a firm with production function Y(L,K,E,M) that chooses factor inputs to abide by profit maximization. K, L, E are capital, labour, and energy respectively, and are perfectly competitive while there exists potential for market power exertion over M, the agricultural input. As such we would have:

$$\pi(L,K,E,M) = R(p,Y(L,K,E,M)) - w(L)\cdot L - r_k(k)\cdot K - r_E(E)\cdot E - r_M(M)\cdot M \tag{12}$$

and the first order condition with respect to M for profit maximization is

$$\frac{\partial\pi}{\partial M} = \frac{\partial R}{\partial Y}\cdot\frac{\partial Y}{\partial M} - \frac{r_M(M)\cdot M}{\partial M} = 0 \tag{13}$$

where $\frac{\partial R}{\partial Y}$ is Marginal Revenue and can be restated as:

$\frac{\partial R}{\partial Y} = p\left(1 - \frac{1}{\varepsilon_{y,p}}\right)$ where p is the price of the output good and ξ is the elasticity of demand.

Analogously, one can derive marginal expenditure on M as:

[11]The methodology used herein assumes estimating an upper bound parametrically, which contradicts the original theme of our model. Nevertheless, this section serves to offer a greater understanding of the market power parameter. To my knowledge, using both parametric and nonparametric systems in the same model for estimation method has not been widely used in the literature.

$$\frac{\partial r_M(M)\cdot M}{\partial M} = r_M + \frac{\partial r_M}{\partial M}\cdot M = r_M\left[1+\frac{1}{\varepsilon_{M\,r_M}}\right]$$ where r_m is the price paid per unit of M and ξ is the price elasticity of supply for good M in the market with respect to r_m .

$$\varepsilon_{M,r_M} = \frac{\%\Delta\, Q_M^s}{\%\Delta\, P_M} \tag{14}$$

Using the previous two equations and profit maximization behaviour we can say that

$$p\left[1-\frac{1}{\varepsilon_{y,p}}\right]Y_L = r_M\left[1+\frac{1}{\varepsilon_{M,r_M}}\right]$$ where the bracketed terms are measurements of market power in output and input markets respectively.

Suppose the firm is perfectly competitive in both input and output markets, it must then be that $p\cdot Y_L = r_M$ and $p\cdot Y_L = MVP$. Now suppose the firm has monopsony power in the input market for M, in other words, $\varepsilon_{Y,P} = -\infty$ but $\varepsilon_{M,r_M} < \infty$. Then we have

$$p\cdot Y_L = r_M\left[1+\frac{1}{\varepsilon_{M\,r_M}}\right] = MVP_M$$, and clearly $MVP > r_m$. In effect, price taking behaviour no longer holds. Moreover, using r_m and $\varepsilon_{M\,r_M}$ one can estimate MVP_M under perfect monopsony power and compare this to the results from the linear program solution to determine the extent of market power exertion by a firm at any time *t*.

Section 6
Extension and Predictions

Section 5 of this paper modified an existing NEIO model of market power to incorporate salient features of the Prince Edward Island processed potato industry. The result of which are based on the well-known Lerner index for market power and compared to two (of three) possible outcomes. First, if the Lerner index results in a measure of zero (0), then the model has predicted the existence of no market power. Secondly, the upper bound of MVP is estimated by using the price elasticity of supply for processing potatoes on Prince Edward Island. If the Lerner index is equal to the upper bound of MVP then the model has predicted market power to be at its largest value possible, thereby assuming that the firms are colluding and acting as ONE processor. In other words, a perfect monopsony. The third case is slightly more involved however. Suppose the Lerner index is somewhere in between perfect competition (0), and perfect monopsony (γ_i), then the market structure must be some form of imperfect competition/cooperation, an oligopsony.

In light of this, the best one could do with the results of this model would be to examine the salient feature of the Prince Edward Island market for processing potatoes and hypothesize as to the structure that would most likely emerge from such characteristics.

Another possible avenue of discussion could entertain the various factors contributing to the number of firms currently in the market. For instance, what are the incentives for entry, and how might incumbents be deterring entry to retain a market with only two players? Work by Aghion and Bolton (1987) may offer some insight into this question.

Firstly, what incentives are extended to new entrants? The primary incentive for a new entrant must be the availability of surplus in a market. Suppose there exists a market where incumbents are exerting market power and are not price takers. There would be some surplus being realized by the incumbents that, given the appropriate conditions, could be shifted to new entrants if they entered. In our case for instance, a new entrant could potentially purchase raw inputs at a cost higher than incumbents, yet lower than MVP. If this were the case new entrants would be better off entering into the market and extracting this surplus. The next question however must be, what are incumbents doing to deter entry and maintain surpluses?

Aghion and Bolton argue that contracts can be an effective tool for deterring entry into a market. Consider an incumbent who has secured contracts with a number of producers, and suppose that these contracts are infinite in nature. Producers are now 'locked-in' to long term bargains with the incumbent, and due to the nature of supply, very inelastic and constrained, new entrants may have to entice producers to violate contractual agreements in order to secure raw inputs for production. If this is the case, new entrants will be require to pay a price that is higher than the incumbents, plus damages incurred by the farmer for violation of the contract, and still maintain prices less than or equal to MVP.

Moreover, it is not unlikely that producers enter into contracts with processors as a means to secure financing. As previously discussed, payment is generally required in-kind, further limiting the supply of raw product to new entrants if producers decide not to breach contracts with the incumbent. This type of behavior works as another entry deterrent since new players are unlikely to enter if there is uncertainty in raw input supply.

One will quickly note however that infinite contracts are not generally observed. So what is keeping new entrants from entering when short-term one year contracts have expired? The lock-in effect. Since processors offer a line of credit to producers that ties the producer to the processor for a length of time greater than one year, and contracts are staggered across producers, there may no feasible entry point for a new entrant so secure enough raw input to be a credible threat. In effect, short-term contracts that offer producers access to financing work to lock the producer into a long-term contract with the processor. Consequently, processors need not offer long-term contracts to secure long-term supplies. As a result, we can observe a difference in the normal length and the effective length of a contract.

Another advantage to maintaining a market with few buyers and many sellers emerges from the fact that processors can secure contracts with many sellers. Suppose more than one farmer, and a potential entrant that must pay a fixed cost of entry (legal fees and/or sunk investment). A processor is more likely to enter with many available farmers since the average cost of entry per farm is lower and the entrant is more likely to extract surplus. If however, incumbents have farmers locked in to long term contracts (either implicitly or explicitly) then entrants have fewer farmers to disperse the costs of entry among, and thus entry is less likely.

In light of all this, one may be able to justify contracts as a means of deterring entry into the Prince Edward Island processed potato industry. By issuing contracts processors are able to deter entry and retain surpluses, and producers are able to secure financing, product demand, and income stability. There are no doubt additional means by which processors stave off entry, yet, the contract method is a readily observable medium and potentially very effective. This area of research would be particularly interesting to pursue given the appropriate data.

Section 7
Discussion

This research paper presented a model of the Prince Edward Island market for processing potatoes and constructed a nonparametric model of market power, based on that of Love and Shumway (1994), which provides a measure of market power similar to the Lerner Index. Although no data was available, and thus no results generated, the paper develops a case for concern with regards to the existence of market power exertion on behalf of processors on producers. Salient features of the market are discussed in detail in order to further understand what exogenous and endogenous factors may be contributing to market power. Contract theory and welfare economics are applied to the Prince Edward Island market and their implications discussed.

We contend that, given the availability of data, the results obtained would be beneficial in aiding to understand the impact of market structure on producers and processors alike. Should results turn out indicating market power, one could consider appropriate action to increase society's overall welfare by implementing welfare transfers or taxing excessive rents.

If results suggested little, or a socially acceptable level of market power, one may consider what factors are contributing to competition over anti-competitive behavior. In turn, this would ensure that the factors attributing to competition could be safeguarded in the face of policy changes or economic shocks.

The next step in this line of research is to develop a method for better interpreting the result of the model described herein. That is, when is L too high? The avenue of research currently being explored seeks to use the results of the linear program to aid in estimating MVP and the elasticity of supply. Given these estimates, one could estimate the share r (or alternatively monopsony mark-up) has of MVP with the use of a modified "Lerner index"[12]. With this information one could better approximate welfare losses due to positive monopsony power, and compare these losses to the costs of policy implications and monitoring. Moreover, one may be able to examine what effects the short- and long-term elasticity of supply has on market power (and vis-versa) and how market power reacts to certain exogenous shocks to the industry as in Just and Chern (1980).

The challenge in this line of research is, of course, to retain the original theme of nonparametric estimation procedures, while retrieving the necessary information required to compare L to a policy alternative with cost α.

[12] This modified Lerner Indexis similar to the one used in Bresnahan (1982) and is equal to $\frac{MVP - r}{MVP} = 1 - \frac{r}{MVP}$

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