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Market Power in the Food Industry:

The Swedish Egg Supply Chain

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Table of content

ABSTRACT

There is an ongoing discussion about the potential increase of market power in the food industry. This study investigates the evolution of market power in the egg supply chain between egg producers and egg packers, using firm-level data from 2001-2019. We use traditional concentration measures and newly developed methods to estimate markups using separate production technologies for egg producers and packers. The markup for egg producers increased between 2002 and 2008, mainly declined between 2008 and 2016, and increased after 2016. For egg packers, markup increased until 2008 and mainly declined after. We find that producers' productivity has a positive impact on packers' markup.

Keywords: Market power, competition, food industry, markups, productivity

1. INTRODUCTION

Market power in the food supply chain is an important policy concern. Food is an essential good, and increased market power in this industry could harm the welfare of farmers and consumers (Sexton, 2013). A food supply chain consists of farmers, food manufacturers, and retailers. In Sweden, retailers and manufacturers typically operate in markets with relatively few actors in comparison to farmers. Farmers are generally small price-taking firms operating in markets with many competitors (Swedish Competition Authority, 2018). Due to this dynamic, farmers are highly susceptible to the market power of food manufacturers. In economics, market power is a reflection of a market with imperfect competition. Implications of increased market power could be higher prices, lower labor demand, and changes in resource allocation (De Loecker, Eeckhout, and Unger, 2020).

In recent years, the food industry has suffered significant structural changes in the supply chain due to technological changes, globalization, agricultural policy, etc. Food retailers at the end of the chain have received much attention due to the increasing concentration.[1] However, there is little research on understanding the changes in market power for food producers and manufacturers. The Swedish egg industry is one sector in the food industry that suffered major structural changes related to the evolution of EU agriculture policy, trade policy, local farming subsidies, and technology. Technological improvements have helped farmers increase productivity and product differentiation, e.g. organic farming. New technology increases economies of scale and scope for egg packers, helping farmers distribute their production faster to consumers, e.g. food retailers and restaurants. As industry experts emphasize, most of the Swedish egg production is sold locally in the county. This is the first research to study the evolution of market power for the Swedish egg supply chain (egg producers and packers) and to highlight the regional differences.

We aim to investigate market power between egg producers and egg packers. Our purpose is therefore to investigate the evolution of market power for egg producers and egg packers in Sweden between 2001 and 2019. To measure market power, we use traditional concentration measures, such as the Herfindahl-Hirschman Index (HHI), and newly developed methods to estimate markups using production technology.[2] First, we estimate separate production

[1] See Dagens Nyheter (2020), The Swedish Competition Authority (2018), European Commission (2019), and Maican and Orth (2017) for example.
[2] HHI is the sum of the firm's market share squared. Markup is defined as the price-cost ratio of a firm.

technologies for egg producers and egg packers, which provide firm-specific estimates of productivity, markup, and their evolution over time. In the absence of information on prices and products inside firms, the recovered markup is an aggregate markup measure over the firm's products. Second, we compute weighted productivity and markups at the county level for producers and packers and examine their trends. Third, we analyze how productivity and concentration for egg producers affect the markups for egg packers.

The egg industry is characterized by many small egg producers and fewer larger egg packers. Egg producers are firms that have egg-laying hens that produce eggs. The egg producers sell their eggs to egg packers, who then clean and package eggs in cartons before selling the packaged eggs, mainly in grocery stores. In our sample, the number of egg producers increased about three times, from 210 in 2001 to 696 in 2019. The average sales of a producer increased from 8 million SEK in 2001 to 11 million in 2019. The number of egg packers increased by 68 percent, from 38 in 2001 to 64 in 2019. As with the producers, the packers also increased their sales, in particular from 35 million in 2001 to 88 million in 2019.

Several previous studies have investigated the potential increase of market power in the food industry (Dobson, Clarke, Davies & Waterson, 2001; Bonner and Dubois, 2010; Sexton, 2013; Sexton and Xia, 2018). It has also been an issue discussed by the European Union in the last decade. In April 2019, the European Commission (2019) adopted a directive called the Unfair Trading Practice Directive (UTP), which supports economically weaker farmers in dealing with economically stronger buyers.

Our results show that firm-level markups for producers were overall higher than for packers. At the beginning of the period, the evolution of markups was similar in both industries. In 2002-2008, the markups increased, followed by a decline in 2008-2010/2011 in both industries. In addition, the markups for packers increased slightly between 2010 and 2013 and for producers between 2011 and 2013. After 2013, the markup for both industries decreased again. From 2016, we see a difference in markups between the industries, as the markup of producers increased by 9 percent in 2016-2019, while the markup of packers continued to decline. Between 2016 and 2019, the packers' markups fell by 12 percent.

At the market level, the key findings are that markups were stable for producers and decreased for packers. The concentration has changed in both industries, and the most significant change was the increase in concentration for packers. In addition, our results show a positive correlation between productivity and markups for both producers and packers at the market level. A key finding about this relationship is that producers' productivity has a positive impact on packers' markups. Furthermore, we conclude that firms in markets with high concentrations have higher productivity and lower markups than firms in markets with low concentrations.

The remainder of the paper is organized as follows: Section 2 discusses previous literature in the context of our study. Section 3 presents the Swedish egg supply chain in terms of market statistics, laws and regulations. Section 4 describes our empirical framework and methodology for estimating markups. Section 5 describes the data. Section 6, presents and analyzes our results, and discusses some limitations of the study. Section 7 contains our conclusion.

2. LITERATURE REVIEW

Various studies have sought to identify the effects of increased market power on the economy (De Loecker & Eeckhout, 2018; Traina, 2018; Basu 2019; Syverson, 2019). According to Syverson (2019), increased market power can be associated with growth in price-cost margins, profit rates, and increased concentration in industries. De Loecker and Eeckhout (2018) states that increased market power can have significant welfare effects, including lower demand due to higher prices. De Loecker and Eeckhout further argue that increased market power of a firm can lead to redistribution of resources from workers to owners, thereby reducing the firms' labor share. Basu (2019) also discusses increased market concentration and decline in labor’s share as potential evidence of increased market power.

Although the potential effects of market power have been investigated in various studies, there is little evidence to support the relationship between market power and the effects discussed on the economy (Syverson, 2019).[3] Syverson discusses various methods of measuring market power and notes that concentration measurements are simple and straightforward measurements, as the economist only needs the firm’s revenue in relation to total revenue in the market to calculate them. Syverson (2019), however, continues by stating that markups are the most direct and accurate measure of market power.

Basu (2019) examines the potential growing market power in the United States, based on three different methods of markup estimation. The third method presented in Basu is similar to the method used in our study, in which one estimates a production function using firm-level data and recovers markups from an optimization for a single input. Based on this method, Basu (2019) argues that the researcher does not have to estimate the rate of economic profit or assume

[3] Syverson examines the different measurements of market power in the macroeconomic literature, such as concentration measured by the Herfindahl-Hirschman index, and markups, defined as the price-cost ratio of a firm.

it is zero. Basu discusses connections between higher markups, lower labor share of income, and lower investment rate. Further, De Loecker and Warzynski (2012) estimate markups for Slovenian firms from 1994 to 2000. They also rely on a similar method to this study to compute markups by estimating production functions without making assumptions about the form of market competition.

De Loecker and Eeckhout (2018) examine the evolution of market power for firms, countries, and the world between 1980 and 2016. The markups are estimated on a firm-level for more than 70 000 firms in 134 countries. In addition, they calculate the average markup by using the sales-weighted average of these individual firms' markup. They conclude that the global markup increased from about 1.1 in 1980 to 1.6 in 2016. Additionally, they estimate that the average markup for Europe increased by 0.66, to 1.64 in 2016, and that the average markup for Sweden increased by 0.50 from 1980 to 1.31 in 2016.

Maican and Orth (2017) look at the impact of an entry of a large food retail store on the productivity of incumbent firms in the market. They conclude that more competition drives productivity. In the case of an entrance of a large store, the low-productivity stores will be forced to exit, and the ones who manage to stay experience an increase in their productivity. Maican and Orth estimate their productivity by using a control function approach based on labor demand. This method of estimating productivity is also the method we will follow in our study.

3. INDUSTRY BACKGROUND

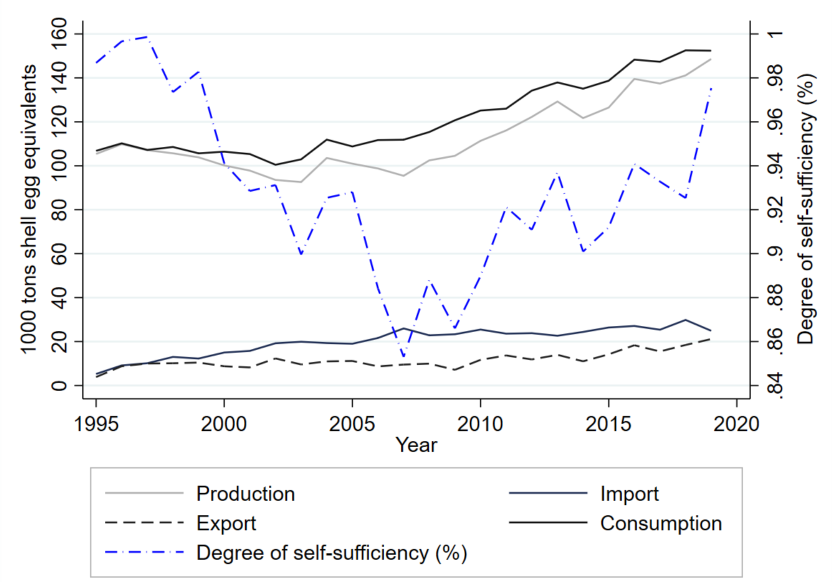
In this section, we present an overview of the egg industry. First, we present a summary of the market for eggs, including Swedish production, trade balance, and demand for eggs. Additionally, the egg producers and egg packers will be presented, including prices, history, and laws they have to follow.

3.1 Market for eggs

Swedish production and trade balance. As shown in Figure 3.1, Sweden produced about 148' tonne shell egg equivalents in 2019.[4] The amount produced in Sweden has steadily increased

[4] Shell egg equivalents is the total production/consumption of egg and egg products, where the egg products are transformed into the equivalent weight of fresh eggs with shell. This is done by Swedish Board of Agriculture to be able to compare the entire production of eggs.

since about 2008. The lowest amount of eggs produced was in 2003, when Sweden produced about 92' tonnes. Between 1995 and 2003, the consumption of eggs fell from 110' tonnes to



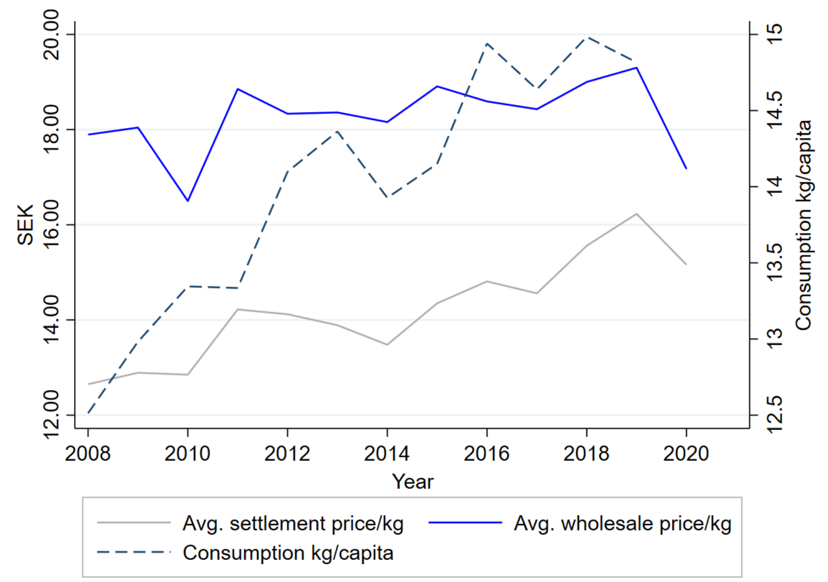
Notes: Consumption is calculated as the total consumption of eggs in Sweden; production + imports - exports. The degree of self-sufficiency is the percentage of eggs consumed in Sweden that were produced in Sweden, calculated by dividing the production with consumption. All of the numbers are excluding eggs sold as ingredients in compound foods. Source: Swedish Board of Agriculture (2021b)

Figure 3.1 Swedish production, trade balance, and degree of self-sufficiency

about 93' tonnes. From 2003 onward, egg consumption increased, and Sweden consumed almost 150' tonnes of eggs in 2020. At the beginning of the period, the degree of self-sufficiency, i.e. the percentage of eggs consumed in Sweden, which were produced nationally, was very high, as can be seen from the dotted blue line. Specifically, in 1997, about 99.9 percent of eggs consumed in Sweden were produced nationally. Furthermore, in 2007, the degree of self-sufficiency was 85 percent, the lowest percentage in the period. Since 2007, the degree of self-sufficiency has increased and was 97.5 percent in 2019.

Both imports and exports of egg products have increased over time. The highest amount of imports was in 2018, when Sweden imported almost 30' tonnes. This amount fell slightly in 2019 to an import of 25' tonne shell egg equivalents, while exports increased to 21' tonnes compared to the previous year. Sweden mainly imports egg products, such as dried, frozen, or liquid eggs, while the main export good is fresh eggs (Swedish Board of Agriculture 2020a). With regard to imports, Sweden has stricter hygiene regulations for egg production than many other EU members. For a thorough description of these laws, see Appendix B.1. Figure 3.2

displays the average settlement price for eggs per kg and the average wholesale price per kg, based on eggs sold in 15-pack cartons on the left axis. On the right axis, the consumption of eggs in Sweden is shown in kg per capita. Consumption per capita has increased from about



Notes: The average settlement price/kg is the price between producers and packers, same as in Figure 3.3. The average wholesale price/kg is from packers to their buyers, same as in Figure 3.6. Source: Swedish Board of Agriculture (2021b)

Figure 3.2 Consumption/capita, settlement prices/kg, and wholesale price/kg

12.5 kg per capita to almost 15 kg per capita in 2019.[5] The average wholesale egg price/kg for 15-pack cartons ranges between 15-19 SEK but has recently declined in 2019 and 2020. The average settlement price of eggs, represented by the grey line, has increased over the years from below 13 to above 16 SEK in 2018. Although in 2020, we note a recent decline to approximately 15 SEK. Settlement price is defined as the price for eggs/kg that egg packers pay to the egg producers, including cost of transport and other costs related to the purchase.

Consumer demand for eggs. Demand for eggs in Sweden has increased by about 9 percent per capita since 1995. Eggs are an animal protein with a relatively low price compared to other proteins, such as meat (Swedish Board of Agriculture 2020a). According to the Swedish Board of Agriculture (2020a), consumers today are also more aware of the effects of various foods on the climate. Demand for chicken and eggs has therefore increased, as they usually generate

[5] This calculation included the consumption of fresh eggs together with different egg products containing egg powder, albumin, and so on, and excluded imported products containing eggs (Swedish Board of Agriculture 2020a).

lower greenhouse gas emissions than beef, pork and milk. Eggs are also marketed as a healthy protein, which can explain the growing demand (Swedish Board of Agriculture 2020a).

Demand for organic eggs has also increased, from nearly no such production to 15 percent of the total egg production in 2015 (Swedish Board of Agriculture, n.d). In 2015, Sweden had about 1,1 million organic laying hens. An organic egg producer has stricter regulations to follow than if producing free-range inside eggs or eggs in enriched cages (Swedish Board of Agriculture, n.d). These regulations are presented in Appendix B.2.

The Swedish Board of Agriculture (2020a) provides information on the 1994 Consumer Price Index for various provisions, such as bread, sugar, meat, egg, and dairy products. They compare prices with an overall consumer price index, which can be regarded as a measure of inflation. They show that the prices of eggs are higher in today's monetary value than in 1994.

EU-market for eggs. The Corona pandemic has led to falling prices and increased surplus in animal products in the European Union (Swedish Board of Agriculture, 2020a). This is due to the fact that restaurants, hotels, and catering were closed or had fewer customers in 2020. When people eat more food at home, demand for some animal products, such as beef and dairy products, decreases (Swedish Board of Agriculture, 2020a; European Commission, 2021).

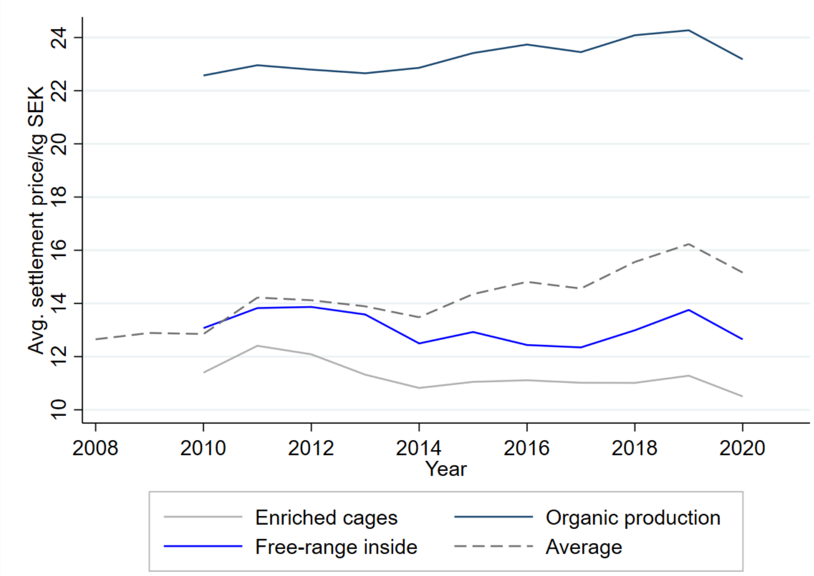
A forecast by the European Commission on egg production in the Union shows that production will increase annually in 2019-2030 and will increase by 9 percent in the period (Swedish Board of Agriculture, 2020a). In 2019, the production of eggs in the EU was about 7065' tonnes of eggs, and the consumption was about 6836' tonnes (Swedish Board of Agriculture 2020a). When it comes to per capita consumption, the average person in Sweden consumes about 14.8 kg per year, while the average EU citizen consumes about 13.3 kg of eggs per year (Swedish Board of Agriculture 2020a).

The EU has a positive trade balance with the outside world in terms of eggs. In 2019, about 19' tonnes of eggs were imported to the EU, whereas there were 247.6' tonnes exported outside the Union. However, in 2012, the prohibition of non-enriched cages led to a lower trade balance. This affected trade, as there were still a large number of such cages on the market (Swedish Board of Agriculture 2020a).

In the Union, there are more caged systems and less organic and free-range inside productions compared to Sweden. In 2017, egg production in the Union was dominated mainly by enriched cages, which accounted for 53 percent, while free-range inside accounted for 27 percent. The amount of free-range outside eggs was 15 percent, and organic eggs was 5 percent in 2017 (Swedish Board of Agriculture 2020a).

3.2 Egg producers

According to the Swedish Board of Agriculture (2020a), there were a total of 2408 firms with hens in 2019. It is common to produce eggs as a part-time or leisure activity (Swedish Board of Agriculture 2020a). Thus, only 237 out of the 2408 firms in 2019 had more than 1000 laying hens. The average number of hens on a farm was about 22 400 in 2020, not including farms with less than 350 hens. This is an increase in the average number of hens by about 4000 per farm since 2011, which results in a total increase of around 2 million hens in Sweden between 2011-2020 (Swedish Board of Agriculture 2020a).



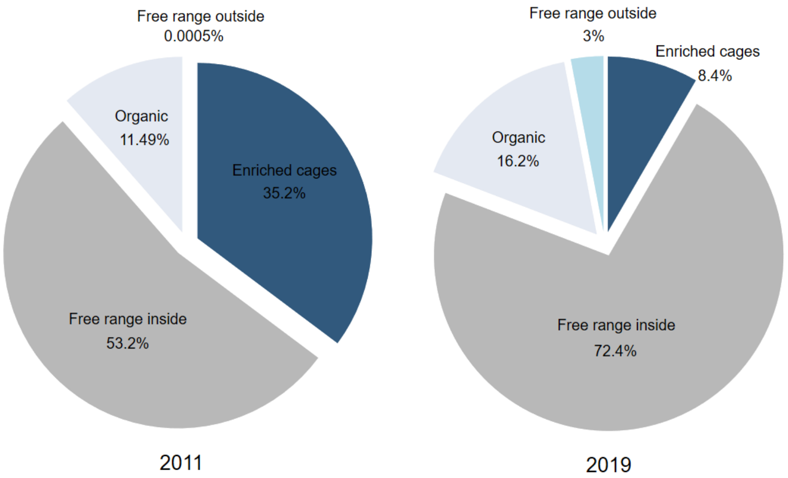
Source: Swedish Board of Agriculture (2021b)

Figure 3.3 Evolution of average settlement prices/kg, between egg producers and egg packers

Figure 3.3 shows the evolution of average settlement prices/kg for different production systems in Sweden. Organic eggs are the most expensive, ranging from 22 to 24 SEK per kg from 2010 to 2020. The dotted line represents a weighted average price for the three different production systems. This price increased during the period and was 15 SEK in 2020. Eggs from the free-range inside production system start at a price of 13 SEK/kg in 2010 and have fallen to about 12.5 SEK/kg in 2020. In 2020, eggs from enriched cages were sold for a little more than 10 SEK/kg. A description of these various production systems can be found in the following section.

Production systems. In January 2012, the EU prohibited non-enriched cage systems, i.e. non-furnished cages (European Commission, n.d). The remaining systems that farmers can use are enriched cages in which laying hens must have at least 750 square cm of cage space per hen (European Commission, n.d). Furthermore, free-range systems inside and outside can be used where the density cannot exceed nine laying hens per square meter. In these free-range systems there must be a nest for every seven hens and adequate perches (European Commission, n.d). Additionally, egg-producing firms must be registered with competent authorities in the respective EU country and have a special egg production number in order to trace back the eggs to the farm of origin (European Commission, n.d).

The Swedish Board of Agriculture (2020a) provides information on the division of production systems in Sweden. Figure 3.4 shows the division of production systems in 2011 and 2019. Over the last decade, there has been an increase in free-range eggs inside, free-range



Source: Swedish Board of Agriculture (2020a)

Figure 3.4 Production systems

eggs outside, and organic eggs. At the same time, eggs from enriched cages have steadily declined over the period, which can be associated with increased demand for organic eggs and free-range eggs (Swedish Board of Agriculture 2020a).

The prohibition of non-enriched cages and the demand for other production systems have affected the egg production market in the last decade.[6] Due to the restructuring of the market,

[6] In Sweden there is an ongoing debate regarding prohibiting all kinds of cages. For more information see Appendix B.3.

there were barns from enriched systems that stood empty in 2001-2019 or were rebuilt to accommodate free-range systems or organic farming (Swedish Board of Agriculture 2020a). The Swedish egg production increased in 2010-2013, followed by a decline of nearly 6 percent in 2014. In 2018-2019, the egg production increased, which led to a surplus and a decline in production prices (Swedish Board of Agriculture 2020a).

Egg producers can apply to receive different subsidies from Sweden and the EU. Depending on the location of the firm, producers can apply for different sizes of support from the Swedish Board of Agriculture (Swedish Board of Agriculture, 2021a). If the producer is in the north of Sweden, the support is larger than for the producers in the south of the country. The EU also offers subsidies to producers seeking help in transforming their production from non-organic to organic (Augère-Granier, 2019).

Why the need for egg packers. To be allowed to sell eggs directly to consumers, the egg producer must be registered with the County Administrative Board (Swedish Food Agency, 2019b). Egg producers are only allowed to sell the corresponding number of eggs that 350 hens can produce in a year without being a registered egg packer (Swedish Food Agency, 2019b). The sale of eggs directly from egg producers to consumers must be carried out on the farm, in town markets, etc. Therefore, in order for egg producers to sell eggs on the consumer market, such as grocery stores, etc., they must sell their eggs to approved packaging companies (Swedish Food Agency, 2019b).[7]

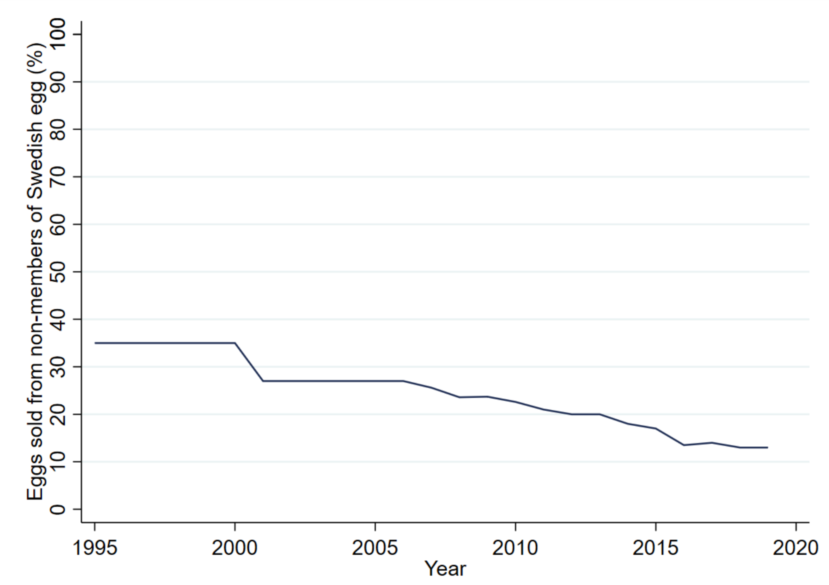
3.3 Egg packers

Eggs sold to consumers are subject to strict quality regulations. According to Swedish law, egg packing firms must be approved by the Swedish Food Agency and obtain a control number that they have to mark every egg with (The Swedish Egg Association, n.d.b). The Swedish Board of Agriculture (2020a) reported that there were 136 Swedish egg packaging firms in 2019. Some of these firms are in close proximity to egg producers, while the larger ones are in close proximity to cities in Sweden (Swedish Board of Agriculture, 2020a).

Figure 3.5 shows the amount of eggs that were not sold by certified egg packers and were instead sold through alternative channels, such as farms or markets. Over the period 1995-2019, the amount of eggs not sold by egg packers has decreased, suggesting that more sales that reach the final consumer go through an egg packer. Figure 3.5 shows that between 1995 and 2001,

[7] Unless they have their own registered packing center at the farm or are in other ways exempt from this law (Swedish Food Agency, 2019b).

about 35 percent of the total amount of eggs produced in Sweden was sold locally on farms or in smaller markets. However, in 2019, about 87 percent of eggs produced were sold through egg packaging companies registered at the Swedish Egg Association, i.e. only 13 percent of eggs were sold through alternative channels.



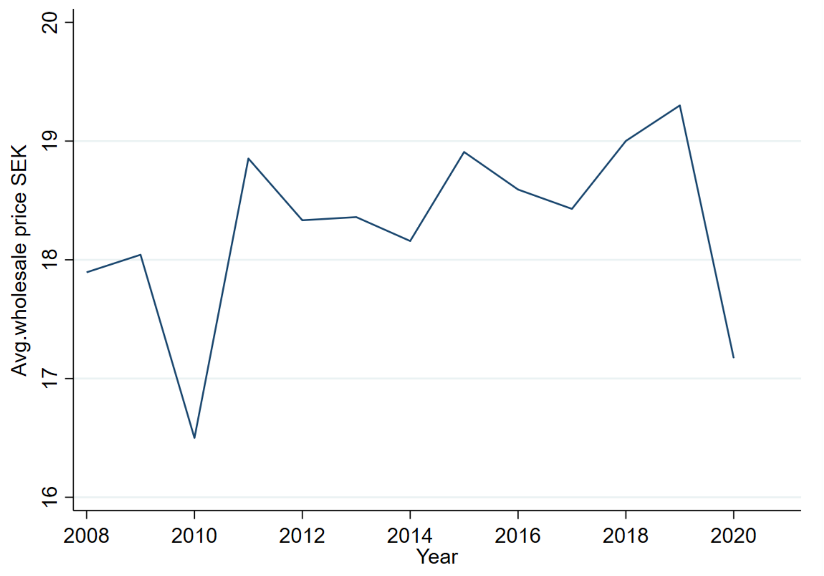
Notes: These numbers are an approximation done by The Swedish Egg Association and are used when calculating the total Swedish production. When calculating the total egg production, The Swedish Egg Association and The Swedish Board of Agriculture take the total weight of eggs weighed in at the member packers of Swedish Egg and then add this percentage to get the total amount produced in Sweden. Source: Swedish Board of Agriculture (2021b)

Figure 3.5 Percent of total production produced and sold from non-Swedish Egg Association members[8]

Figure 3.6 shows the average wholesale price per kg, i.e. the price for which packers sell their packaged eggs. This price data is collected weekly by the European Union and calculated from the prices of eggs in 15-pack cartons (Swedish Board of Agriculture, 2021b). In 2019, the price was 19 SEK/kg, the highest price observed in the period. However, after 2019, it fell to a price of 17 SEK/kg in 2020.

In accordance with the European Commission Regulation (EC) No 589/2008 of 23 June 2008, eggs that reach the consumers must be of the highest quality. To indicate the quality of the eggs, they are classified as either A- or B-eggs (Swedish Food Agency, 2021). A-eggs are the eggs that we can buy in our grocery stores, for example. B-eggs are eggs with smaller defects that are sold to the food industry, for example. To check the quality of the egg, egg

[8] The Swedish Egg Association is an egg trade organization. Their members are companies working with egg hatching, hen raising, egg production, egg packing, and feed manufacturing (The Swedish Egg Association, n.d.a).



Notes: Average wholesale price is an average price/kg for eggs from free-range inside hens in 15-packs. Source: Swedish Board of Agriculture (2021b)

Figure 3.6 Average wholesale prices/kg from egg packers to retailers

packers shine a light through the eggs to find cracks or problems with the inside, and to ensure that there is no dirt left on the egg surface. When this is done, the eggs are marked with a code indicating what production method, which EU-country and what farm the egg is from. The final step is to sort the eggs according to weight classifications and pack them in egg cartons (Swedish Food Agency, 2019a).

In the European Union, there are laws and regulations regarding the food industry and trade of food between EU countries, which aim to standardize food production. For a description of these regulations, see Appendix B.4.

3.4 Unfair trading practices

In April 2019, the European Commission adopted a directive called Unfair Trading Practice (UTP), which supports farmers in bargaining with buyers.[9] The directive was adopted in response to a debate in the European Union over the increase of market power in the food industry between farmers and food manufacturers in the last decade, where farmers must accept unfair trading practices to continue selling their products. Therefore, this directive primarily supports and protects farmers and their cooperatives. The directive also protects suppliers of

[9] Sweden needs to transpose this directive into national law by April 2021 and apply it 6 months later (European Commission, 2019).

agri-food products, usually small and medium-sized enterprises and manufacturers or distributors, in their bargaining power with large buyers (European Commission, 2019).

The directive protects firms along the food supply chain, depending on the relative size of the farmer, against their buyers (European Commission, 2019). For example, a micro farmer with a turnover of less than two million euros is protected from a buyer that has a turnover that exceeds two million euros. Further, a small farmer with a turnover above two million euros, but not exceeding 10 million, is protected against buyers that have a turnover higher than 10 million euros.

The directive consists of 16 unfair trading practices, in which 10 practices are "black," which means they are prohibited, while the rest are "grey," which indicates that suppliers and buyers can agree on them beforehand (European Commission, 2019). Some examples of "black" unfair practices are that farmers are not paid on time, have to pay for wasted food, and get their orders cancelled at a short notice. The "grey" practices mainly concern the return of unsold products and the payment of the supplier for promotion, marketing, and advertising. The directive supports farmers in various areas, such as those that produce cereals, animals, fruit and vegetables, milk, animal feed, cut flowers, but also processed products such as chocolate and dairy products.

4. EMPIRICAL FRAMEWORK

In this section, we start with a discussion of how to define and measure market power. Further, we present the empirical framework for the study of market power. We begin by introducing the method behind the calculation of concentration in a market. Finally, the theory and estimation method of markups as a measure of market power is presented.

Market power reflects imperfect competition in a market, which usually results in firms setting their price above costs. Market power, however, is not an exact science, as there are different ways to measure and define this phenomenon. The OECD (2002) defines market power as the ability of a firm or group of firms to keep their prices above the price if the market were competitive. Syverson (2019) defines market power as the ability of a firm to decide on the markup of its products. As far as a measurement of market power is concerned, a simple approach is to look at the concentration in a market. The concentration measurement Herfindahl-Hirschman Index (HHI) is one of the most commonly used methods of measuring market power (De Loecker and Eeckhout, 2018). However, market concentration measurements have been criticized for not being appropriate or accurate in understanding the complexity of market power in an economy (De Loecker and Eeckhout, 2018; Syverson, 2019). Syverson concludes that markups are a more accurate way of measuring a firm's market power.

The definition of markup is the ratio of price for the firm's output and marginal cost for producing that output. Measuring markups is difficult, mainly because as a researcher, the prices and costs of a firm are difficult to obtain. Consequently, various methods have been developed to estimate a firm's markup without access to the firm's prices and costs (see Ackerberg, Caves and Frazer, 2015; Basu, 2019; Syverson, 2019).

This study uses both market concentration and estimated markups to investigate the evolution of market power in the Swedish egg industry. Market concentration is measured by HHI, while markups are estimated with a method that estimates the output elasticity of labor and the share of expenditure on labor in terms of total revenue (see Ackerberg et al., 2015; Maican and Orth, 2017; Olley and Pakes, 1996).

Concentration. In order to map a specific market, the market share of firms in that market is a relevant measure. The market share is calculated by dividing the sales of the firm with the total sales in the market. The share of firm *i*, in county *m*, in time *t* is denoted as s_{imt}, where *n* is the number of firms in the market, see equation (1)

$$s_{imt} = \frac{sales_{imt}}{\sum_{i=1}^{n} sales_{imt}}. \quad (1)$$

With the market shares of firms in the market, it is possible to calculate the concentration in the market, which is determined by the number of firms in the market and their market shares. If there is high market concentration, there is a small number of firms that account for the majority of the market and vice versa. There are different market concentration measurements: one of the primary measurements is the HHI (Pepall, Richards & Norman, 2014). HHI is calculated by taking the sum of squared market shares of all firms in the particular market. The calculation is as follows:

$$HHI_{mt} = \sum_{i=1}^{n} s_{imt}^{2}. \quad (2)$$

If there is only one firm in the market, i.e. a monopoly, HHI is equal to 1. On the other hand, if there is a large number of firms with a similar share in the market, HHI approaches 0 (Dobson et al., 2001).

Markup. Markup (μ) is defined as the ratio of price of the output (*P*) and marginal cost for producing that output (*MC*) (Syverson, 2019). Definition (3) stems from the price-cost relationship $P = \mu * C$, assuming the firm is maximizing its profits the cost (*C*) can be set equal to the marginal cost. This allows for the interpretation of μ as a multiplicative factor that makes the price-cost relationship hold, by definition (Syverson, 2019):

$$\mu = \frac{P}{MC}. \tag{3}$$

Taking the logs, rearranging and differentiate the equation we end up with:

$$\frac{dP}{P} = \frac{d\mu}{\mu} + \frac{dMC}{MC}. \tag{4}$$

⇔[Growth in price] = [Growth in markups] + [Growth in MC].

In general, according to Syverson (2019) growth in price has been unusually low over the past decades. Meanwhile the growth in markups have been unusually high and the growth in marginal cost has been steady, making the above relationship (4) difficult to understand. Decomposing the markup definition (3) is informative in understanding why this is possible. The markup can be rewritten by including average costs:

$$\mu = \frac{P}{MC} = \frac{P}{AC}\frac{AC}{MC}. \tag{5}$$

The AC/MC ratio is the scale elasticity of the cost function (η). If MC<AC, scale elasticity is greater than one implying that there are economies of scale. In this case average costs are falling in the quantity produced. A firm's revenue (*R*) minus its total costs (*TC*), divided by revenue is defined as a firm's profit share of revenues s_π:

$$s_\pi = \frac{R-TC}{R}. \tag{6}$$

Thus, one end up with the expression:[10]

[10] $Calculation: 1 - s_\pi = \frac{R}{R} - \frac{R-TC}{R} = \frac{TC}{R} = \frac{AC*Q}{P*Q} = \frac{AC}{P} * \frac{P}{AC} = \frac{1}{1-s_\pi}$

$$\mu = \frac{1}{1-s_{\pi}} \eta. \qquad (7)$$

From equation (7) it can be shown that the levels of markup indicate what profit shares and/or scale elasticities should be. So, if markups increase over time, there must be an increase in pure profit's share of revenue of the firm or in scale elasticities, or both (Syverson, 2019).

De Loecker and Warzynski (2012) presents a method of estimating firm-level markups by the use of production function estimates without access to data on prices and costs. Their method is based on a method originally developed by Robert Hall. Hall outlined a way of estimating markups using firm behavior and aggregate data in a collection of papers (Hall 1986, 1988). We will follow the method outlined by De Loecker and Warzynski with a few differences regarding the estimation of the production function parameters. The empirical model in De Loecker and Warzynski (2012) is based on the main assumption that every firm is cost minimizing in their decision making about variable inputs, free of adjustment costs. The model is built on estimated output elasticities and the firm's input expenditures as a share of total revenues to estimate the markups. The output elasticity of an input is derived from an estimated production function and the input expenditures share is derived from data on input expenditures and total sales (De Loecker and Warzynski, 2012).

De Loecker and Warzynski (2012) states that under the assumptions that $Q(\cdot)$ is continuous and twice differentiable with respect to its arguments, the production technology is defined as:

$$Q_{it} = Q_{it}(X_{it}^{1}, \ldots, X_{it}^{V}, K_{it}, \omega_{it}). \qquad (8)$$

Meaning that firm *i* produces output *Q* at time *t*. There are *v* number of inputs $(X_{it}^{1}, \ldots, X_{it}^{V})$, for example labor. Labor is assumed to be a static input into production without adjustment costs, i.e. free from hiring and firing costs. K_{it} is the capital stock of firm *i* at time *t*, and ω_{it} is the productivity of firm *i* at time *t* (De Loecker and Warzynski, 2012). The capital stock is a dynamic input of production, which means that choices of capital in period *t* are done subject to an investment process. In contrast to labor (which is non-dynamic), capital stock for period *t* has been determined in the period $t-1$. Under the assumption that the producers in the market are cost minimizing, firm *i* have the following static optimization problem in period *t*:

$$min_{X_{it}^{1}, \ldots X_{it}^{v}} [P_{it}^{X^1} X_{it}^{1} + \ldots + P_{it}^{X^v} X_{it}^{v} + P_{it}^{k} K_{it}]. \qquad (9)$$

The following Lagrangian function can be stated as:

$$L(X_{it}^{1},\ldots,X_{it}^{V},K_{it},\lambda_{it}) = \sum_{v=1}^{V} P_{it}^{X^v} X_{it}^{v} + r_{it}K_{it} + \lambda_{it}(Q_{it} - Q_{it}(\cdot)) \tag{10}$$

where, $P_{it}^{X^v}$ and r_{it} are the firm's input price for a variable input *v* and capital. For a variable input without adjustment costs the first-order condition is

$$\frac{\partial L_{it}}{\partial X_{it}^{v}} = P_{it}^{X^v} - \lambda_{it}\frac{\partial Q_{it}(\cdot)}{\partial X_{it}^{v}} = 0 \tag{11}$$

where $\lambda_{it} = \frac{\partial L_{it}}{\partial Q_{it}}$ is the marginal cost of production at a given level of output. Equation (12) is reached by rearranging terms in (11) and multiplying by $\frac{X_{it}}{Q_{it}}$ on both sides

$$\frac{\partial Q_{it}(\cdot)}{\partial X_{it}^{v}}\frac{X_{it}^{v}}{Q_{it}} = \frac{1}{\lambda_{it}}\frac{P_{it}^{X^v}X_{it}^{v}}{Q_{it}}. \tag{12}$$

Optimal demand for input X is reached when a firm sets the output elasticity ($\theta_{it}^{X^v}$) of any variable input X_{it}^{v} equal to $\frac{1}{\lambda_{it}}\frac{P_{it}^{X^v}X_{it}^{v}}{Q_{it}}$, implied by the assumption of cost minimization. By the use of the conditional cost function (12) one can find the firm's markup. Markup is defined as $\mu_{it} \equiv \frac{P_{it}}{\lambda_{it}}$. Defining markup in such a way saves one from having to consider different price setting models or characterize what price competition there is among firms on the market. The definition does require the assumption that prices are set period by period, meaning that there is no menu pricing or other dynamic pricing models (De Loecker and Warzynski, 2012). Using the definition of the markup μ_{it} as the price-marginal cost ratio allows equation (12) to be rewritten into:

$$\theta_{it}^{X} = \mu_{it}\frac{P_{it}^{X}X_{it}}{P_{it}Q_{it}}. \tag{13}$$

The ratio on the right-hand side of eq (13) are the inputs' cost share (α_{it}^{X}). Meaning that optimal demand for an input X is when $\theta_{it}^{X} = \mu_{it} * \alpha_{it}^{X}$. Rearranging this expression yields the estimated markup for firm *i* at time *t*:

$$\mu_{it} = \theta_{it}^{X}(\alpha_{it}^{X})^{-1} \quad (14)$$

where α_{it}^{X} is share of expenditures on input X_{it} in total sales, i.e. $P_{it}Q_{it}$, and θ_{it}^{X} is estimated output elasticity on an input X. Thus, it is possible to measure the markup of a firm by estimating the output elasticity of one variable input (such as labor) and the expenditure share of that input.

Identification and estimation procedure. To estimate a firms' markup without access to their prices and costs, as in De Loecker and Warzynski (2012), we need to estimate the production function. There are different methods of obtaining these production function estimates used in the literature. The most commonly used methods are derived by Olley and Pakes (1996), Levinsohn and Petrin (2003), and Ackerberg, Caver, and Fraser (2015). These three methods are based on each other, and use observed input decisions to "control" for unobserved productivity shocks.

We use a production function with a scalar Hicks-neutral productivity term and common technology parameters for all firms. These restrictions give us the following general production function for firm *i* at time *t*:

$$Q_{it} = F(L_{it}, K_{it}; \beta)exp(\omega_{it}) \quad (15)$$

where, Q_{it} is the output, L_{it} is the variable input labor, and K_{it} is the dynamic input capital. β is a set of common technology parameters that, together with the productivity of the firm denoted ω_{it}, decides the transformation of inputs to units of output (De Loecker and Warzynski, 2012). Capital letters denote variables in level and lowercase letters denote the variable in log.

We observe the output y_{it}, which is assumed to be defined by $y_{it} = lnQ_{it} + \epsilon_{it}$ (16). The error term (ϵ_{it}) denotes shocks to production that are not related to the firm's input and investment decisions as well as measurement errors. For each firm separately, the production function is estimated using:

$$y_{it} = f(l_{it}, k_{it}; \beta) + \omega_{it} + \epsilon_{it}. \quad (17)$$

The general production function (17) shows that a firm's output is a function of labor (l_{it}), the dynamic input capital (k_{it}), and their respective coefficients (β). Output is also affected by productivity and the error term. For simplicity, the constant is assumed to be included in the productivity term.

To obtain consistent estimates for the production function De Loecker and Warzynski (2012) argue that one needs to control for unobservable productivity shocks, since they can be correlated with the chosen input, in our case labor. Firms are assumed to know their productivity at the time of making decisions about inputs, but the productivity is unknown to the researcher. To deal with these problems when productivity is endogenous and also assumed to be non-linear, Olley and Pakes (1996) suggests using a control function approach.

We use labor as an input demand choice to estimate productivity, in line with Maican and Orth (2017).[11] Labor is assumed to be a static and variable input, and that firms choose their amount of labor based on current productivity. Labor demand is a function of capital, productivity, and wage (w_{it}), see equation (18). $\widehat{l_t}$ is a non-parametric function that is increasing in productivity and is invertible

$$l_{it} = \widetilde{l_t}(k_{it}, \omega_{it}, w_{it}). \tag{18}$$

Wage is included as a control variable in the labor demand function (18). This is because wages also affect the optimal labor demand choice of a firm, together with capital and productivity. When the proper demand function is defined it is possible to estimate and analyze the markup of firms, and how the markups differ between firms, and over time. It is also possible to analyze how markup is related to other characteristics of a firm. To express productivity as a function of known variables we invert (18). This is possible under the assumption that the demand for labor is strictly increasing in productivity conditional on the capital stock and wages. This assumption holds as long as firms with a higher productivity do not have immensely higher markups compared to less productive firms (Maican and Orth, 2017).[12] By inverting (18) we end up with the following proxy for productivity

$$\omega_{it} = \tilde{l}_t^{-1}(l_{it}, k_{it}, w_{it}). \tag{19}$$

For equation (19) to be a valid proxy for productivity we make the additional assumption that there is only one firm specific state variable that is unobservable i.e. productivity. With these assumptions in place, estimating the production function can now be done without considering the exact model of competition (Olley and Pakes, 1996).

To start we consider the following sales translog production function

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[11] Using labor demand instead of investments means that we do not have to restrict our sample to only include firms with non-zero investment. Using firms with an investment of zero could violate the assumption about the demand function strictly increasing in productivity (Ackerberg et al., 2015). Choosing labor over material was a result from lack of available data on materials for these firms.

[12] This is true in our data, see Appendix B.1

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_l l_{it} k_{it} + \omega_{it} + \epsilon_{it}. \qquad (20)$$

The control function approach is a two-step non-parametric procedure to recover the unobserved firm productivity. The first step of the non-parametric approach is to obtain an estimate of the non-parametric function $\widehat{\phi_t}$ i.e. the sales output without ϵ_{it}. This is done by using the inverted labor demand function (19) as a proxy for productivity by replacing ω_{it} in (20) with $\tilde{l}_t^{-1}$. In the first step, Olley and Pakes (1996) estimates β_l, although issues with the identification of β_l in the first step have been raised. Hence, to avoid possible identification problems due to multicollinearity, both β_l and β_k will be estimated in the second step, as in Ackerberg et al. (2015) and Maican and Orth (2017). In the first stage the sales generating function is:

$$y_{it} = \phi_t(l_{it}, k_{it}, w_{it}) + \epsilon_{it}. \qquad (21)$$

The purpose of this first estimation is to obtain an estimate of the expected sales output (ϕ_t), clean from shocks (ϵ_{it}). The expected sales output without output shocks is thus given by:

$$\phi_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{lk} l_{it} k_{it} + \tilde{l}_t^{-1}(l_{it}, k_{it}, w_{it}) \qquad (22)$$

ϕ_t is approximated by the use of a polynomial series expansion of order 3 using the OLS estimator (Maican & Orth, 2017). In the second stage, given the estimated output ($\widehat{\phi_t}$), firm productivity can be recovered as a function of the parameters $\beta = (\beta_l, \beta_k, \beta_{ll}, \beta_{kk}, \beta_{lk})$:

$$\omega_{it}(\beta) = \widehat{\phi_t} - \beta_l l_{it} - \beta_k k_{it} - \beta_{ll} l_{it}^2 - \beta_{kk} k_{it}^2 - \beta_l l_{it} k_{it}. \qquad (23)$$

Thus, for a value of β_l and β_k, it is possible to compute the productivity using (23). The productivity is now clean from the shocks to output (ϵ_{it}).

In the second stage, estimates will be provided for all coefficients in the production function, using the law of motion for productivity

$$\omega_{it} = g_t(\omega_{it-1}) + \xi_{it}. \qquad (24)$$

We assume that productivity follows a first-order Markov process, i.e. $\omega_{it} = \rho_0 + \rho_1 \omega_{it-1} + \rho_1 \omega_{it-1}^2 + \rho_1 \omega_{it-1}^3 + \xi_{it}$, where the error term ($\xi_{it}$) is assumed to be productivity shocks that are independent of firm-observable information in time *t-1*. Recalling equation (23) as a measure of productivity based on expected sales output, we can rewrite the production function as the following:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{lk} l_{it} k_{it} + g_t(\hat{\phi}_{t-1} - \beta_l l_{it-1} - \beta_k k_{it-1} - \beta_{ll} l_{it-1}^2 - \beta_{kk} k_{it-1}^2 - \beta_l l_{it} k_{it-1}) + \xi_{it} + \epsilon_{it}. \quad (25)$$

The estimates of the coefficients in the production function are identified by using the Generalized Method of Moments (GMM) estimator. By nonparametrically regressing $\omega_{it}(\beta)$ on its lag, following the first-order Markov process, and obtaining the error term, we can use moments based on productivity shocks in our GMM estimation.

Assuming that the amount of capital a firm has is decided in *t-1* and that the amount of labor to employ is decided in time *t*, we can use the following moments to estimate the coefficients of the production function

$$E(\xi_{it} | l_{it-1}, k_{it}, l_{it-1}^2, k_{it}^2, l_{it-1} k_{it}) = 0. \quad (26)$$

As in De Loecker and Warzynski (2012) we use labor in *t-1* to identify the labor coefficient, since labor in *t* is assumed to not be independent of shocks to productivity in time *t*, i.e. $E(l_{it}\xi_{it}) \neq 0$. Once the estimated coefficients of the production function are obtained, the output elasticity of labor can be calculated. Under the sales translog production function, the equation for output elasticity for labor is

$$\widehat{\theta_{it}^L} = \widehat{\beta_l} + 2\widehat{\beta_{ll}} l_{it} + \widehat{\beta_{lk}} k_{it} \quad (27)$$

(De Loecker & Warzynski, 2012). The second measure needed to calculate markups is the expenditure share of labor in total revenue i.e. α_{it}^L. Recall that $\alpha_{it}^L = \frac{P_{it}^L L_{it}}{P_{it} Q_{it}} = labor\ cost / total\ revenue$. Although, we do not directly observe output i.e. Q_{it} we observe Y_{it}, which is given by $Q_{it} exp(\epsilon_{it})$ (see eq. (16)). This means that the estimated expenditure share of labor $\hat{\alpha}_{it}^L$ is given by

$$\hat{\alpha}_{it}^L = \frac{P_{it}^L L_{it}}{P_{it} \frac{Y_{it}}{exp(\hat{\epsilon}_{it})}} \quad (28)$$

where P_{it}^L is the price of one unit of labor and L_{it} is the quantity of labor, ϵ_{it} is the error term obtained in the estimation of (21). Not correcting the estimated expenditure share with ϵ_{it} could lead to wrongful results. By using equation (28) we remove the variation in expenditure shares that stems from variation in output that is not correlated with $\phi_t(l_{it}, k_{it}, w_{it})$ The final step is to calculate the markup μ_{it}, which is done by using the following equation

$$\mu_{it} = \hat{\theta}_{it}^{L}(\hat{\alpha}_{it}^{L})^{-1} . \tag{29}$$

5. DATA

This study is limited to include the Swedish egg producers and egg packers. It is also limited to firms that produce fresh eggs for consumption, which accounts for about 85 percent of total egg production in Sweden (Swedish Board of Agriculture, 2020a). The Swedish egg market is highly self-sufficient, as about 97 percent of eggs produced in Sweden are consumed nationally (Swedish Board of Agriculture, 2020a). Thus, the limitation of only including Swedish firms who produce, and package fresh eggs should not influence our results.

Some of the larger egg packaging firms have the whole country as their market. Although egg producers and egg packers operate mainly locally and compete with other firms geographically close to them, according to Lönneskog.[13] Sweden is divided into 21 counties, which are used to define a firm's market. This means that a market in our study is defined as one county and one year for producers or packers. One example of a market is Blekinge County in 2001 for producers.

In the following sections, the data collection process and firm categorization will be explained. In the last subsection, we present descriptive statistics of various firm-specific variables, including the number of employees, net sales, fixed assets, labor productivity, labor share, as well as concentration in the different counties.

5.1 Data collection and firm categorization

The data is collected from the database Retriever Business based on two different SNI codes, 01471 “Egg production” and 46330 “Wholesale of dairy products, eggs, and edible oils and fats”. The collection of egg producers was mainly based on the SNI code 01471. The firms collected were compared to a list of certified egg producers by the Swedish Egg Association (n.d.b). We added additional firms from the list to the data that were not initially collected on the basis of the SNI code.

[13] Marie Lönneskog, CEO The Swedish Egg Association. E-mail correspondence 2nd of February 2021.

Firms collected from the SNI 46330 included many firms that were not active in the egg industry. To ensure that the study only contained relevant egg packers, we used a list called "Eggs and egg products" by the Swedish Food Agency (n.d.) as the main source instead of the SNI code 46330. This list is continuously updated and contains every registered egg packer in Sweden, as egg packers must be registered with the Swedish Food Agency to operate their business.[14]

When the data collection was completed, we conducted a thorough investigation of the firms involved to verify that they actually were egg producers or egg packers.[15] First, we looked at the SNI code and description of the firm's main activities. If there was any uncertainty about the activity, the firms were further investigated by checking their websites and/or social media. The main activity was determined by checking what the firm wrote about its number of hens, whether they sell eggs to consumers or grocery stores, whether they package eggs, etc.

When investigating the firms, we realized that there were some that both had the SNI code 01471 for egg production and were certified packers. In these cases, we investigated the firms more carefully, and we noticed that some of them actually produced and packaged their own eggs. At this stage, we decided to divide the firms into three categories: producers, packers, and both. The firms who had the SNI code 01471 and whose main activity was egg production were labeled *producer*. These firms have egg-laying hens that produce eggs sold to packers or in small quantities to consumers. The firms on the list of approved egg packers from the Swedish Food Agency received the label *packer*. These firms have a packaging facility and package eggs they receive from producers. They usually sell their eggs to grocery stores, both local and national. Finally, if the firm was both active in egg production and in egg packaging, it got the label *both*. These firms are egg producers with an approved packaging facility and usually sell their packaged eggs to local grocery stores or directly to consumers through their farm shop.

After this labeling process, we investigated the different categories and noticed that the firms labeled both were not different from packers, both in terms of size and product market, as both sell eggs to a certain extent. These categories were also similar with regard to firm characteristics, such as number of employees, labor productivity, sales and so on. As a result, we decided to merge the categories and ended up with producers and packers/both. For simplicity, we call packers/both packers throughout the study.

[14] Åsa L.N., Swedish Food Agency Mail correspondence 4 February 2021

[15] As stated in Section 3.2, the majority of egg producers in Sweden are producing eggs as a part-time or leisure activity which made it more crucial for us to investigate the firms. A few firms, 12, were removed since they were not active in the egg industry at all.

The final data set is an unbalanced panel data of 19 years, as all firms did not exist in the entire period 2001-2019. In 2001, the number of firms was 248, divided by 210 producers and 38 packers. From the 210 producers, 81 firms had data, while 28 firms had data for packers. The firms in this study have different types of company forms. Depending on what company form the firm has, they are obligated to report different amounts of information about their business. As a result, the firms have different amounts of data available. A majority of egg producers are sole proprietorship, which means that these firms do not have much data available. The majority of egg packers are limited companies, which means that more data is available for these types of firms. For a complete description of the various company forms we have in our data set, see Appendix B.5.

5.2 Descriptive statistics

In the following section, we present the descriptive statistics for the egg market and the variables used in the estimation of productivity and markups. Table 5.1 presents the variables used in the estimation procedure, and what they are called in the empirical framework.

Table 5.1 Variable description

Variable name	Definition
Total fixed assets	Capital
Number of employees	Labor
Net sales	Output
Personnel cost	Wages

Table 5.2 shows the number of firms in each county in the years 2001, 2010, and 2019, in our data. The total number of producers in 2001 was 210, and 696 in 2019. There were three counties in 2001 who had more than 30 producers: Skåne, Västra Götaland, and Östergötland. Together, these three counties contained about 50 percent of all the producers in Sweden in 2001. In 2019, the number of producers in these counties accounted for 40 percent of the total number of producers in Sweden. The total number of packers went from 38 in 2001 to 64 in 2019. Skåne, Västra Götaland, and Östergötland had the most packers as well in 2001. They all had five or more firms, together holding about 50 percent of the total number of packers in 2001. In 2019, these three counties accounted for 40 percent of the total number of packers.

Net sales for each market are shown in full in Appendix A.2. Total net sales for producers increased by 129 percent from 2001 to 2019. Total net sales for packers increased from 2001 to 2019 by 227 percent. In 2001, producers had about double the amount of sales compared to packers. Although, in 2019, this difference decreased, and packers' sales were about 79 percent of the producers.

Table 5.2 Number of firms by year, type of firm, and county

	Number of firms					
	Producers			Packers		
County	2001	2010	2019	2001	2010	2019
Blekinge	8	8	13	1	1	2
Dalarnas	8	12	21	1	1	1
Gotlands	9	11	21	1	1	1
Gävleborgs	6	12	24			
Hallands	17	21	33	4	5	6
Jämtlands	2	7	25	1	1	3
Jönköpings	7	13	39	1	2	2
Kalmar	13	15	24	3	3	3
Kronobergs	1	6	21			1
Norrbottens		2	12		1	1
Skåne	31	43	88	5	6	6
Stockholms	2	4	25	2	3	3
Södermanlands	3	5	17	2	5	5
Uppsala	5	11	34	2	2	2
Värmlands	3	7	23			1
Västerbottens	3	9	21			1
Västernorrlands	2	5	18		1	1
Västmanlands	6	7	15		1	1
Västra Götalands	34	52	106	6	9	12
Örebro	9	16	33	1	3	4
Östergötlands	41	60	83	8	8	8
Total	210	326	696	38	53	64

In order to present descriptive statistics for concentration, we first calculated market shares and further the HHI for producers and packers, see equations (1) and (2) in the empirical framework. Table 5.3 presents the HHI for each market in 2001, 2010, and 2019. For producers, the market with the highest concentration in 2001 was Stockholm County, who had a HHI of 1. The county with the lowest concentration in 2001 was Östergötlands County. In 2019, there were three markets with a HHI of 1. Stockholm County is not one of them, because this market had more than one producer in 2019. Further, the packers' markets with a HHI of 1 are more common compared to producers. In 2001, 8 out of the 21 markets had a HHI of 1, whereas in 2019 11 markets had a HHI of 1.

Table 5.3 Herfindahl-Hirshman index by county

	HHI County					
	Producer			**Packer**		
County	2001	2010	2019	2001	2010	2019
Blekinge	.731	.575	.501	1	1	1
Dalarnas	.761	.909	.899	1	1	1
Gotlands	.504	.609	.282	1	1	1
Gävleborgs	.857	.381	.629			
Hallands	.184	.177	.163	.549	.737	.721
Jämtlands	-	-	1	1	1	.999
Jönköpings	-	-	.603	1	1	1
Kalmar	.236	.219	.233	1	1	1
Kronobergs	-	1	.267			1
Norrbottens		-	1		-	1
Skåne	.249	.189	.254	.4	.333	.267
Stockholms	1	.985	.79	1	.657	.513
Södermanlands	.798	.404	.227	.77	.786	.513
Uppsala	.775	.801	.625	1	1	1
Värmlands	-	-	1			1
Västerbottens	.541	.465	.353			1
Västernorrlands	-	.568	.504		1	1
Västmanlands	.523	.694	.59		-	-
Västra Götalands	.28	.181	.147	.585	.4	.294
Örebro	.533	.399	.184	-	-	.25
Östergötlands	.137	.133	.105	.485	.596	.606

Notes: The markets with an "-" are counties that have firms that year, but those firms do not have any recorded sales. Markets that do not have an HHI are counties that do not have any firms that year.

In Table 5.4 the HHI is summed over the counties for producers and packers for the years 2001, 2010, and 2019. In both industries, the average county had an increase in concentration over the time period. For producers, there has been a 22 percent increase in concentration and for packers there has been a 6 percent increase. In addition, the 25th percentile market for producers experienced a 243 percent increase in HHI, while packers had a 22 percent increase.

Table 5.4 Descriptive statistics Herfindahl-Hirshman index

Variable	Obs	Mean	Std. Dev.	Min	p25	p50	p75	Max
Producer								
2001	20	0.405	0.336	0	0.068	0.392	0.746	1
2010	21	0.414	0.331	0	0.177	0.399	0.609	1
2019	21	0.493	0.306	0.105	0.233	0.501	0.629	1
Packer								
2001	14	0.755	0.318	0	0.504	0.940	1	1
2010	17	0.665	0.374	0	0.500	0.786	1	1
2019	20	0.800	0.271	0	0.616	0.972	1	1

Markets in the 75th percentile experienced a 16 percent decrease for producers and were stable for packers.

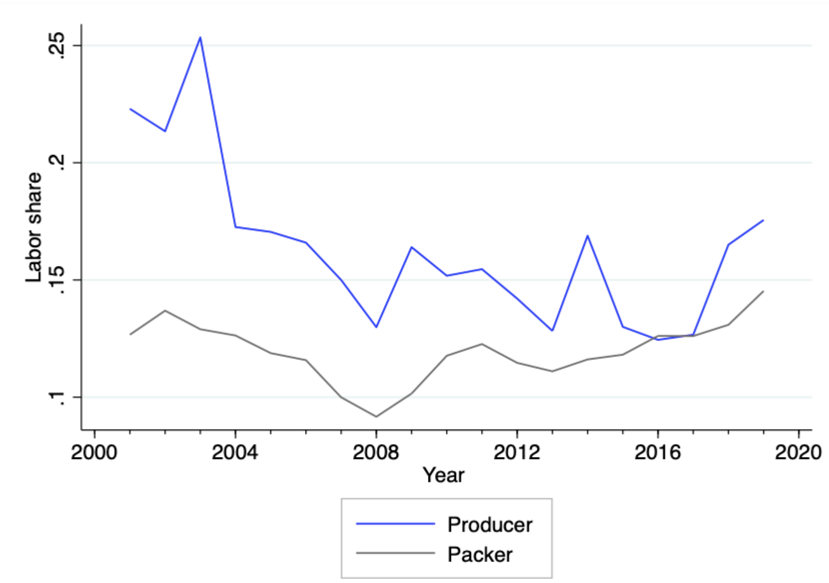
Table 5.5 Descriptive statistics: Number of employees, number of companies, log net sales, and log total fixed assets

Variable	Obs	Mean	Min	p25	p50	p75	Max
Producer							
Number of emp.	2283	5.509	1	2	3	5	123
Number of firms	7049	36.363	1	15	28	54	106
Log net sales	2283	8.167	0	7.915	8.730	9.214	12.557
Log total fixed assets	2282	7.248	0	6.553	7.885	8.827	11.752
Packer							
Number of emp.	655	12.522	1	4	7	12	111
Number of firms	972	5.210	1	3	5	8	12
Log net sales	655	9.151	0	8.564	9.480	10.679	13.814
Log total fixed assets	655	7.924	0	7.220	8.458	9.433	12.741

Notes: The variable number of employees is calculated by adding one employee to every firm. This is done to account for the owner of the firm who is not registered as an employee in the data. Number of companies has a larger number of observations because the variable includes all firms in the data, i.e. those firms with no data on sales, number of employees etc.

Table 5.5 presents descriptive statistics of the number of employees, the number of companies, net sales, and total fixed assets. Producers in the 75th percentile had 60 percent more employees per firm than the producers in the 25th percentile. For packers, this difference was 67 percent. When it comes to the number of firms, the producers in the 75th percentile had

72 percent more firms than the producers in the 25th percentile, whereas for packers this number was 63 percent. Regarding net sales, producers in the 75th percentile had 14 percent higher sales than producers in the 25th percentile. For packers, this percentage was about 20 percent. Finally for fixed assets, producers in the 75th percentile had 26 percent higher fixed assets than the producers in the 25th percentile, while for packers this difference was 23 percent.



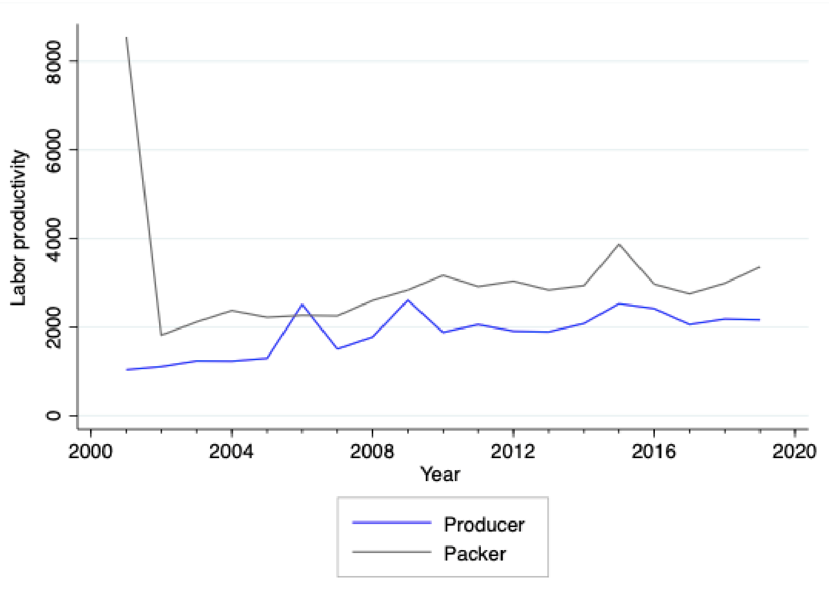
Notes: The average labor share is calculated by creating a mean labor share for each market and taking the average of that over all of the markets in one year.

Figure 5.1 Average labor share by county

Figure 5.1 shows that the average labor's share for producers was higher than the average labor's share for packers, except for during 2016 and 2017, when the average labor's share for producers and packers was about 0.3. Overall, producers had a decline in labor's share until 2017, when the trend changed, and the labor's share increased. Packers had also experienced a decline in the labor share, although only until around 2008 when their labor's share increased. For a complete presentation of the mean labor share for each market, see Appendix A.3.

The average labor productivity for producers has in general been lower than the average labor productivity for packers (Figure 5.2). From 2002, both industries followed a similar pattern of slightly increasing productivity. However, at the beginning of the period, there was a sharp decline in productivity for packers. See Appendix A.3 for a full presentation of mean labor productivity for each market.

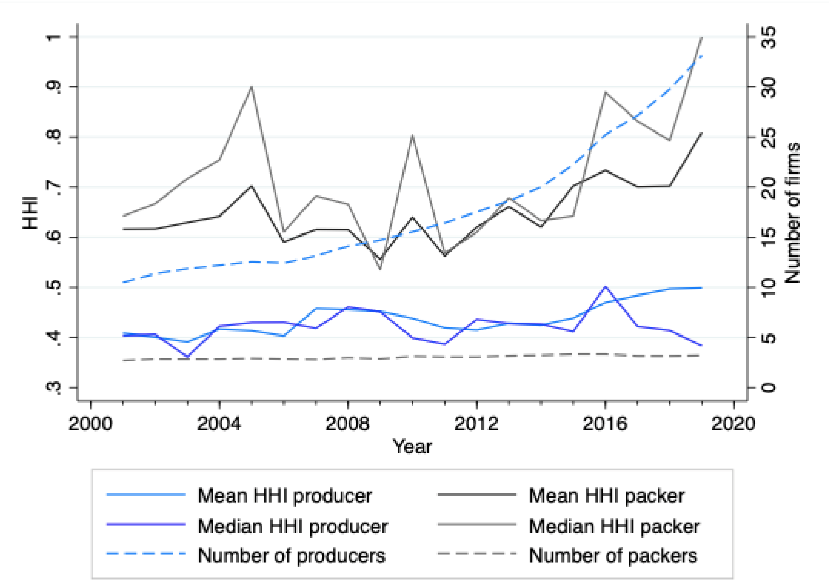
Figure 5.3 shows the relationship between HHI and the number of firms for producers and packers. The concentration in the markets for producers is lower than for packers. In 2019, the



Notes: The average labor productivity is calculated by creating a mean labor productivity for each market and taking the average of that over all of the markets in one year.

Figure 5.2 Average labor productivity by county

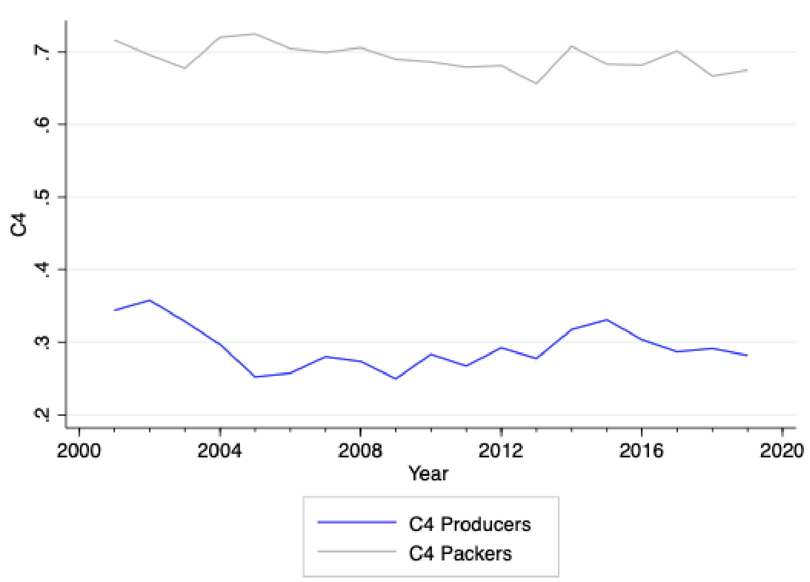
median HHI for packers reached one, meaning that the median market for packers only had one firm. In the same year, the median HHI for producers was slightly below 0.4, which was almost the lowest observed median HHI in the period. In addition, there was an average increase in the number of producers in an average market, while the number of packers was about the same for the entire period.



Notes: Mean and median HHI means that a mean and median is taken over the markets. Number of firms is the mean number of firms in one market. Number of firms is shown on the right y-axis and are the two dotted lines, whereas the mean and median HHI are shown on the left y-axis. Lines corresponding to producers are blue and lines corresponding to producers are grey.

Figure 5.3 HHI mean, HHI median, and number of firms

Figure 5.4 shows the concentration ratio of the four largest firms in each year. In 2001, the producer industry´s four-firm concentration ratio (C4) was 34 percent, meaning that in 2001 the four largest producers had 34 percent of the market for producers.[16] In the same year, the



Notes: The four-firm concentration ratio (C4) is a measurement calculated by the sum of the market share of the four largest firms in the market.

Figure 5.4 Four-firm concentration ratio (C4) for producers and packers

four largest packers had 72 percent of the market for packers. In addition, the C4 decreased in both industries during the period, and in 2019, the four largest producers had 28 percent of their market, while the four largest packers had 67 percent of their market. According to economic theory, producers have competed effectively in the last two decades, while there has been a tight oligopoly competition in the packer market.

6. ANALYSIS & RESULTS

This section starts with a presentation of the estimated productivity, output elasticity, and markup at the firm level. Following is a presentation of the evolution of HHI, productivity, and markup over time at the market level. We use the firm-level markup and productivity and

[16] By definition if C4 is about 0 percent the market has perfect competition, 0-40 is defined as effective competition. When the ratio is 40-60 percent, the market is defined as a loose oligopoly and over 60 percent the market is a tight oligopoly (Naldi & Flamini, 2014).

aggregate them by counties to obtain the market-level markup and productivity. Finally, we present the results of potential driving forces of markup.

6.1 Productivity, output elasticity, and markup at the firm level

From the process of estimating the production function, we also estimate the productivity of a firm. Productivity follows a Markov process and is endogenous. Table 6.1 displays the evolution of productivity for producers and packers.

Table 6.1 Evolution of productivity for producers and packers

Dependent variable	**Productivity in t**			
	Producers		**Packers**	
Variables	Estimate	t value	Estimate	t value
Productivity in t-1	0.94977	36.332	0.92362	0.03018
Productivity squared in t-1	0.02368	0.998	0.01891	0.01984
Productivity cubed in t-1	0.01940	0.762	-0.01472	0.01186
Adj. R-squared:	0.859		0.8773	
	Median		Median	
Persistence in productivity	0.9572		0.9037	

Table 6.1 shows that the persistence in productivity for producers is about 95 percent, meaning that 5.1 percent of productivity in time *t* is explained by other factors than productivity in $t-1$. For packers, the median persistence in productivity is 90 percent.[17] Thus, compared to producers, a higher percentage of the productivity in t for packers is explained by other factors than productivity in $t-1$. Further, from Table 6.2 we see that the distribution of productivity is lower for packers, since both Q1 and Q4 is lower compared to producers.

Table 6.2 presents descriptive statistics for the output elasticity of labor and capital, productivity, and markup at the firm level.[18] Increasing the amount of labor generates a higher output for producers compared to packers, since the output elasticity of labor for the median producer is 19 percent higher than for the median packer. Producers also have a more widespread distribution of the output elasticity of labor. Producers in the 75th percentile have

[17] The coefficients are jointly significant.
[18] The output elasticity labor and capital ($\theta_{it}^{L}, \theta_{it}^{K}$), is calculated with the use of the estimated production function, see equation (27). The output elasticity of labor is one of the components needed to calculate the markup of firms, see equation (29) in the empirical framework.

a 25 percent higher output elasticity of labor compared to the producers in the 25th percentile, while the difference for packers is 12 percent.

Table 6.2 Descriptive statistics for output elasticity of labor and capital, productivity, and markup

	Producer			Packer		
Variables	p25	p50	p75	p25	p50	p75
Output elasticity labor	0.302	0.346	0.402	0.259	0.280	0.295
Output elasticity capital	0.189	0.226	0.269	0.362	0.430	0.514
Productivity	5.029	5.228	5.494	1.341	1.736	2.174
Markup	1.721	1.912	2.103	1.476	1.592	1.748

The persistence in the output elasticity of labor is 96 percent for producers and 95 percent for packers.[19] Increasing the amount of capital generates a higher output for packers than for producers. The median output elasticity of capital for packers is 47 percent higher than for producers. The persistence in the output elasticity of capital is 95 percent for producers and 93 percent for packers.[20]

Productivity for producers in the 75th percentile is 9 percent larger than the productivity for producers in the 25th percentile. For packers, this difference is 38 percent. Ergo, producers do not have a major difference in productivity between each other, while packers tend to have a larger difference. The productivity of the median producer is 67 percent higher than the productivity of the median packer.

The markup is higher for producers than for packers. The markup for a median producer is 17 percent higher than for a median packer. The producers in the 75th percentile have a markup of 18 percent higher than the producers in the 25th percentile. For packers, the 75th percentile firms have a 16 percent higher markup than the firms in the 25th percentile.

Figure 6.1 shows the firm-level productivity for producers and packers over time. Producer productivity, as shown on the left, has increased over time. From 2002 to about 2008, the median productivity of producers increased by 6 percent. Between 2008 and 2019, median productivity increased by 2 percent, a total increase of almost 6 percent. Productivity for producers in the 75th percentile also increased by about 6 percent from 2002-2019. In 2002, the productivity of a median producer was 62 percent higher than the productivity of a median packer. In 2019, the difference was 69 percent, see the right panel of Figure 6.1. Over the

[19] See Appendix A.4
[20] See Appendix A.4

period, the productivity of a median packer decreased by 11 percent. Between 2002 and 2005, the productivity of a packer in the 75th percentile decreased by 27 percent. From 2005 and

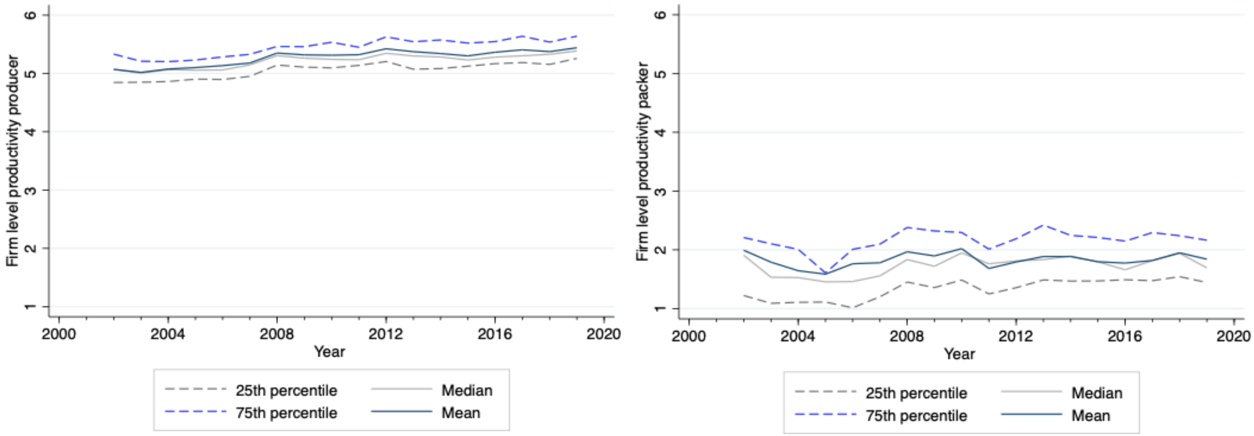


Figure 6.1 Evolution of productivity over time at firm level

onward the productivity increased by 31 percent. The productivity for a packer in the 75h percentile decreased by a total of 2 percent.

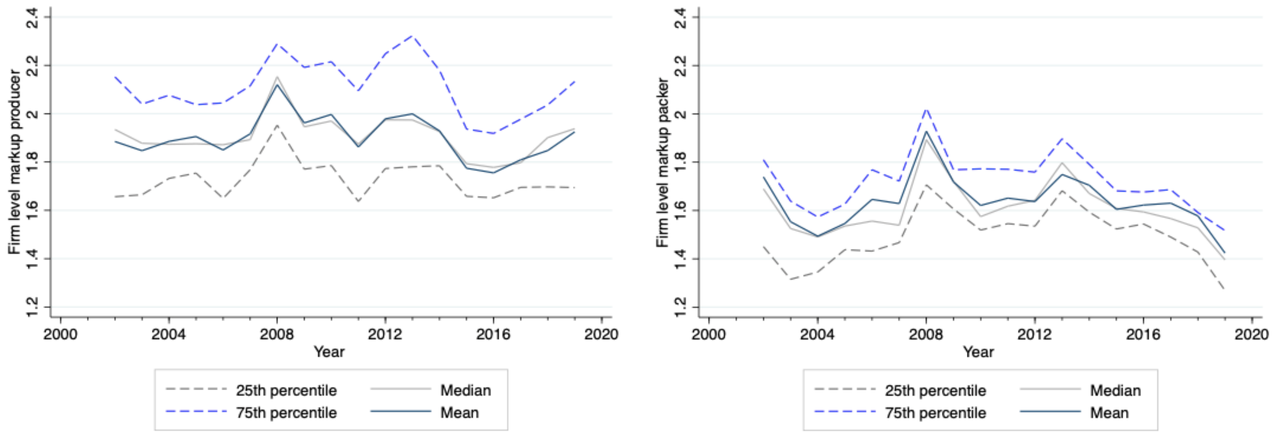


Figure 6.2 Evolution of markup at firm level over time

Figure 6.2 displays the firm-level markup for producers and packers over time. The markup for a median producer was 13 percent higher than for a median packer in 2002, and in 2019 it was 28 percent higher. Between 2002-2008, the markup for a median producer increased by 32 percent. From 2008-2011, markups decreased for a median producer, followed by a rise until 2013. After 2013, markups declined again, but from 2016, markups increased by 9 percent for producers. The total change from 2002-2019 for a median producer was 1 percent. The markup for producers in the 75th percentile follows a similar pattern as the median, with a total change of negative 1 percent.

In Figure 6.2, it is shown on the right that packers have experienced a similar trend in markups until 2016. As for producers, markups for a median packer increased by 12 percent from 2002-2008. From 2008 to 2010, the markups fell by 17 percent, followed by a slight increase until 2013. Median markups for packers fell by 22 percent after 2013. The total decrease in markups for a median packer was 17 percent and 16 percent for packers in the 75th percentile. Hence, producers and packers had a similar evolution in markups until 2016. Since 2016, the markups of producers have increased, and the markups of packers have decreased. Figure 6.2 shows that the distribution of markups for packers is narrower than for producers. A narrower distribution means a smaller difference in markups between packers in the 25th percentile and the 75th percentile compared to producers.

Identifying what impacts markups at firm level. To understand what changes markups for a firm, we test the impact of productivity and log of capital on firm-level markup, along with the persistence in markup, controlling for variation across year and county. The results of these regressions are presented in Table 6.3 for producers and Table 6.4 for packers.

Table 6.3 Persistence in markups, and the impact of productivity and capital on markup

Dependent variable	**Markup Producer**			
Variables	(1)	(2)	(3)	(4)
Markup t-1	0.783***			0.737***
	(0.0228)			(0.0245)
Productivity		-0.219***	-0.236***	-0.0985***
		(0.0362)	(0.0337)	(0.0225)
Log of capital			0.0805***	0.0186***
			(0.00791)	(0.00555)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	705	705	705	705
Constant	Yes	Yes	Yes	Yes
Adj. R2	0.675	0.151	0.264	0.687

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 6.3, specification (1) shows the persistence in markup for producers based on an estimated AR(1) process. The persistence is 78 percent, meaning that 22 percent of markups in time t are determined by other factors than markups in $t-1$. Specifications (2), (3), and (4) show that producers with a high productivity have lower markups, all else equal. The magnitude of the effect decreases when controlling for markup in $t-1$ and capital but is still negative. The coefficient of productivity in specification (4) is -0.099 and statistically significant at the one percent level.

In specifications (3) and (4), the log of capital is added. The results show that producers with a high amount of capital have higher markups, all else equal. The coefficient for the log of capital in specification (4) is 0.02 and statistically significant at the one percent level. In this specification, all three variables are controlled for, as well as the variation across year and county. The value of the coefficient for markup in $t-1$ is very similar and still significant compared to specification (1). Adjusted R-square for specification (4) shows that almost 69 percent of variation in markups is explained when controlling for all three variables, and the year and county variation.

Table 6.4 Persistence in markups, and the impact of productivity and capital on markup

Dependent variable	**Markup Packer**			
Variables	(1)	(2)	(3)	(4)
Markup t-1	0.798*** (0.0326)			0.779*** (0.0352)
Productivity		0.0376* (0.0208)	-0.00884 (0.0209)	-0.00412 (0.0128)
Log of capital			-0.0732*** (0.0119)	-0.0110 (0.00777)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	323	323	323	323
Constant	Yes	Yes	Yes	Yes
Adj. R2	0.794	0.375	0.446	0.794

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 6.4, specification (1) shows the persistence in markups for packers based on an estimated AR(1) process. The specification also controls the variation across year and county.

The persistence between markup in $t-1$ and markup in time t is almost 80 percent, meaning that 20 percent of markup in t is determined by other factors. Specification (3) shows that packers with a high amount of capital have lower markups, all else equal. The coefficient for the log of capital is -0.07 and statistically significant at the one percent level. In specification (4), the magnitude of the coefficient of capital decreases compared to (3). However, in (4) the coefficient is no longer significant, but the sign is still negative. In (4), we observe that packers with high productivity could have lower markups, all else equal. Although, the coefficient for productivity is not statistically significant and quite small in magnitude. The variables in specification (4) explains 80 percent of the variation in markup for packers.

Discussion about output elasticity and markups at the firm level. We find that the estimated output elasticity of labor is higher for producers than for packers at the firm level (Table 6.2). These results indicate that producers increase their output more by adding extra labor compared to packers. The output elasticity of capital for packers is higher than for producers, implying that adding additional capital for packers increases their output more compared to producers. Furthermore, we find that producers in our data are more labor-intensive than packers.

When analyzing the evolution of markups over time, it is worth noting that we observe a downturn in markups after the financial crisis of 2008, both for producers and packers. From 2008 to 2010/2011, the markups for producers decreased by 13 percent, compared with 17 percent for packers. Since then, the markups of producers have recovered, and as mentioned earlier, the markups of producers have steadily increased since 2016. In contrast, packers' markups did grow a little in 2013, but the median markup has decreased since then.

It is interesting to compare the changes in prices with the changes in markup for both producers and packers. For example, after the financial crisis, from 2009-2010, the wholesale price decreased by 8 percent, and the settlement price remained constant. The markups for producers and packers also decreased in 2009. Overall, the settlement price of eggs increased by 23 percent from 2008-2019, while the wholesale price of eggs only increased by 5.5 percent (Figure 3.3).[21] Also, worth noting is that during this period, the demand and supply of eggs increased. An increase in the settlement price is an increase in the cost of the packers, and the fact that the wholesale price has not increased by the same percentage suggests that the packers have increased their cost of buying eggs without receiving the same increase in the price of selling their eggs. Packers also had no significant productivity increase on average, and the

[21] Settlement price is the price paid by packers when buying eggs from producers. The wholesale price is the price retailers pay when buying eggs from packers.

market-level productivity for packers actually decreased. All these findings suggest that the process of packaging eggs has become more expensive over the period without an increase in the selling price to cover the costs. In 2019-2020, the wholesale price of eggs fell by 10.5 percent. Although we do not observe markups for 2020, we observe that in recent years there has been a negative trend in markups for packers that could be related to the decline in price. We also know that there was a surplus of eggs in 2019 that could explain the drop in wholesale prices. The settlement price has also dropped in 2019, by around 6 percent.

Changes in production technology for producers are also relevant when discussing changes in markups. From Figure 3.5, we find that organic and free-range inside production of eggs has increased, while the enriched cage production has decreased. The settlement price for eggs from these production systems is higher than for enriched cages, and the price for organic eggs is almost twice as high as the price of eggs from free-range inside. Since we only have the wholesale price of 15-pack free-range inside eggs, we cannot say anything about the difference in settlement price and wholesale price for the different production systems. However, more variation in production systems between producers increases their diversification and could explain the increased markup for producers.

Increases in competition and market power have been linked to a decline in the labor's share of income (Syverson, 2019). In our data, we observe this relationship during some periods. For producers, labor's share declined on average between 2001-2008, where markups simultaneously increased 2002-2008 (Figure 5.1 and Figure 6.2). After 2008, labor's share increased a little, followed by a decrease, which can be connected to the decline in markups after 2008. Although, from 2017, both markups and labor's share have increased for producers, which is not in line with previous research. For packers, markups also increased 2002-2008, whereas labor's share decreased during the period. After 2008, there has been an increase in labor's share, with a slight decrease from 2011-2013. This can be connected to the slight rise in markups during 2010-2013, followed by a decline since 2013. Thus, for packers, the relationship between labor's share and markups seems in line with previous research over the whole period.

Discussion on potential driving forces of markups at the firm level. Our findings from Figures 6.1 and 6.2 show that productivity for producers has increased, and that markups for producers have increased and decreased over the period. According to classic growth models, higher markups should stimulate productivity growth, since firms compete more fiercely to displace incumbents from the market in which there is a possibility to recover profits (Basu, 2019). Although in Table 6.3, we find in testing the relationship between markups and productivity that producers with high productivity tend to have lower markups. This result could be because producers who are more productive than their competitors produce more output with the same amount of inputs. Since the producers' markets tend to be competitive, the highly productive firms can sell more eggs at a lower cost, obtaining a larger part of the market by keeping their prices and markups a little lower.

We can also conclude that producers with high capital have higher markups. One explanation for this relationship could be that firms who invest in capital might set higher markups to cover their cost. We know that during the time of this study, many producers have invested in transitioning from enriched cage production to organic production. Organic eggs sell at a higher price and are more expensive to produce, allowing for higher markups. In the long-run, investments in capital should increase the productivity of a firm (Maican and Orth, 2015). According to our results, productivity decreases the markup for producers. From this knowledge, one could argue that the positive relationship between capital and markups is due to investments made due to market transition, and that the effects of capital on markups could be negative in the long run. On the contrary, we find that packers with high capital have lower markups. A negative relationship between capital and markup is more in line with traditional economic theory, which states that higher markups should reduce capital demand (Basu, 2019).

6.2 Concentration, weighted productivity, and weighted markup

Using the method described in section 4, we have obtained the following variables: markup, productivity, and HHI. Markup and productivity are variables at the firm level, whereas HHI is by definition at the market level. As a reminder, a market in this study is one county, one year for either producers or packers. In order to analyze markup and productivity together with HHI at the market level, we have created weighted market averages. In order to analyze markup and productivity together with HHI at the market level, we have created weighted market averages. These weighted averages have been calculated by multiplying the markup (μ_{imt}^{x}) or productivity (ω_{imt}^{x}) with the market share (s_{imt}^{x}) for firm i in industry x, in county m at time t:

$$HHI_{mt}^{x} = \sum_{i=1}^{m} s_{imt}^{2} \quad (30)$$

$$\overline{\Omega}_{mt}^{x} = \sum_{i=1}^{n} (\omega_{imt}^{x} * s_{imt}^{x}) \quad (31)$$

$$\bar{\mu}^{x}_{mt} = \sum_{i=1}^{n}(\mu^{x}_{imt} * s^{x}_{imt}) \tag{32}$$

Here, HHI^{x}_{mt} is the HHI for one county in one year, $\bar{\mu}^{x}_{mt}$ is the weighted markup at market level, and $\bar{\Omega}^{x}_{mt}$ is the weighted productivity at market level.

The following sections describe the evolution of HHI, markup and productivity at the market level. After presenting the results for the evolution of these variables over time, we analyze what drives the weighted average markup. First, the effect of concentration on productivity is investigated. Secondly, the effect of productivity on markup, and lastly, the effect of concentration on markup.

Evolution of HHI. We use the HHI for producers and packers to answer how market concentration has changed for producers and packers from 2001 to 2019. For a graphical understanding of the evolution of HHI over time, the sample was reduced to include only three years, 2001, 2010, and 2019 (see Figure 6.3). The box-plots represent the distribution of HHI in the 21 counties for three years.[22] From a policy perspective, the most interesting markets are the ones with a high HHI, where the competition usually is low. Thus, the focus of the analysis will be on changes in the median and the 75th percentile markets.

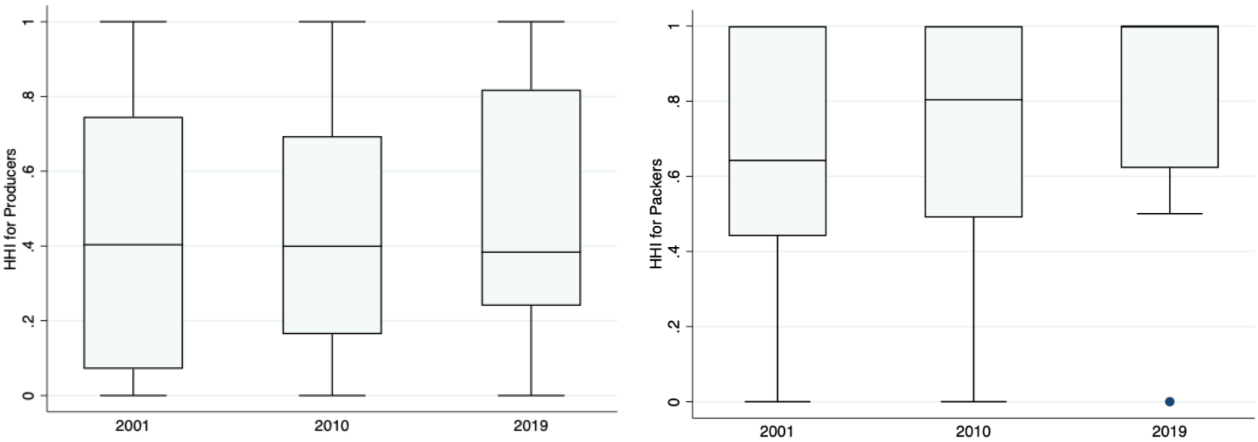


Figure 6.3 Distribution of HHI over the counties for producers and packers

[22] The boxes represent the interquartile range, which indicates how spread out the middle 50 percent of all observations are. The whiskers represent the minimum and maximum values in the distribution and the dots represent outliers.

The median HHI for producers decreased 5 percent over the period 2001-2019, as shown in the left panel in Figure 6.3. The HHI for markets in the 75th percentile increased by about 7 percent over the time period. This shows that markets with a high concentration were even more concentrated at the end of the period. Figure 6.3 also shows that the interquartile range decreased over time. Thus, in 2019, the box was smaller and higher up, suggesting more markets for producers with a higher concentration in 2019 than in 2001. Since HHI is determined by the number of firms in the market and their market share, the results of the box plots can be further explained by the change in the number of firms in the different markets. In the median market, the number of producers was 6.5 in 2001, 11 in 2010, and 24 in 2019. The markets in the 75th percentile had 11 producers in 2001, 15 in 2010, and 33 in 2019.

The right panel of Figure 6.3 presents the distribution of HHI for packers. The concentration in the median market increased by 25 percent between 2001 and 2010 and the same amount between 2010 and 2019. This is a total increase of 50 percent in the median market. In 2001 and 2010, markets in the 75th percentile had a concentration of 1, which means that 25 percent of counties had only one firm in those years. In 2019, on the other hand, both the median and the 75th percentile market had a concentration of one, meaning that 50 percent of the markets had one firm. Thus, there has been an increase in concentration in the median market, whereas the concentration in the 75th percentile market has been stable. In 2019, there is one county where HHI is 0 due to no firms. This is represented by the blue dot. It can also be seen that the interquartile range has decreased and that more markets have gained higher concentrations over the period. In order to connect concentration with the number of companies in the market, the median market had 2 packers for the entire period. In the 75th percentile, the number of packers increased from 4 in 2001 to 4.5 in 2019.

Evolution of productivity. In the estimation procedure of the production function, we use lagged variables, resulting in first estimates of productivity and markup in 2002. Figure 6.4 shows two box plots of the distribution of productivity. Productivity for the producer in the median market decreased by about 15 percent from 2002-2019, as shown in the left panel of Figure 6.4. From 2002-2019, the dispersion of productivity increased. More precisely, productivity for producers in the 25th percentile decreased by about 52 percent, while productivity for markets in the 75th percentile was stable. Thus, the producers' markets with a productivity lower than the median got an even lower productivity.

Productivity in the markets for packers was on average lower than productivity in the markets for producers. Productivity for the median market for packers decreased by around 29 percent between 2002 and 2019, as shown in the right panel in Figure 6.4. The interquartile range was narrow in 2002, which means that the majority of markets had a productivity close to the median. There were some outliers in 2002, where two markets had a productivity close to zero and two markets had an unusually high productivity. For markets in the 75th percentile,

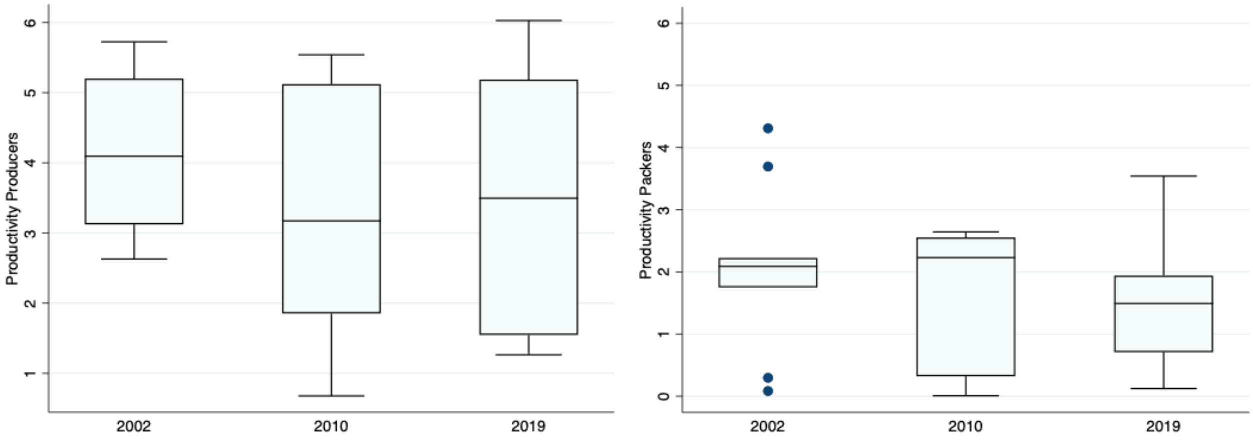


Figure 6.4 Weighted average productivity over the counties for producers and packers

productivity decreased over the period, in particular around 14 percent. The markets in the 25th percentile also experienced a decline in productivity. The evolution of market-level productivity over the whole period 2002-2019 can be seen in Appendix A.F1.

Evolution of markups. To answer how markups on a market level changed for producers and packers from 2001 to 2019, we use the weighted average markup ($\bar{\mu}_{mt}^{x}$). For a graphical understanding of the evolution of markups over time, the sample was reduced to only three years, 2002, 2010 and 2019 (see Figure 6.5). The box plots show the distribution of the weighted markups over the years in the 21 counties. In the interpretation, we will focus on the markets with the highest markups, i.e. the median and 75th percentile, as they are probably the markets where competition is harmed the most.

Figure 6.5, in the left panel, shows the distribution of weighted markups for producers over the counties. The markup for producers in the median market decreased by 14 percent in the period 2002-2019, while the markup for the market in the 75th percentile was stable in the period. When it comes to the interquartile range, there was an increase over the period, seen by the larger box and the increased upper whisker in 2019. From Figure 6.5, one can conclude that the median market for producers had a decline in markups over the period, while markups for the market in the 75th percentile were stable.

As shown in the right panel in Figure 6.5, the median market for packers had a slight decline in markups over the period by about 7 percent. Markups for packers in the 75th percentile

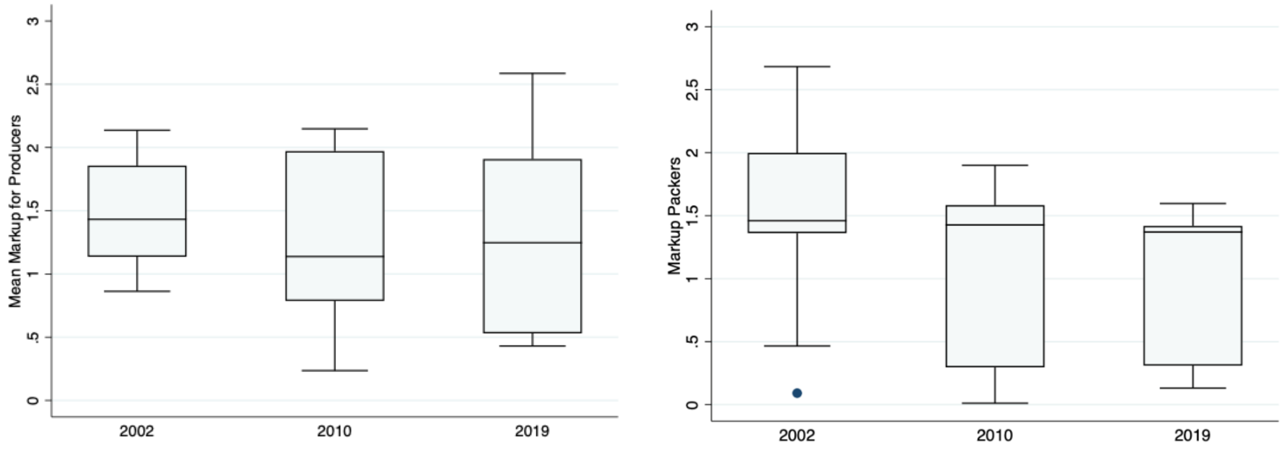


Figure 6.5 Weighted average markups over the counties for producers and packers

decreased by about 30 percent in 2001-2019. At the same time, markups for packers in the 25th percentile fell dramatically with 79 percent. These results indicate that the variability of markups for packers has changed considerably during the time period. In 2002, there was a small interquartile range and large whiskers indicating more values in the extremes. In 2019, the interquartile range grew, and the whiskers were much smaller compared to 2002. From Figure 6.5, one can conclude that the median market for packers had a slight decline in markups over the period, whereas the market in the 75th percentile had a larger decline. For a full presentation of the evolution of markup for the whole period 2002-2019, see Appendix A.F2.

How concentration affects productivity. First, we investigate the effect of concentration in $t-1$ (HHI_{mt-1}^{x}) in own industry on productivity $(\overline{\Omega}_{mt}^{x})$ in own industry, controlling for unobserved variables that vary over time but not across counties (f_t). Second, the effect of producers' concentration in $t-1$ (HHI_{mt-1}^{y}) on packers' productivity is investigated, also controlling for year fixed effects. We choose concentration in $t-1$ as an explanatory variable, assuming that a firm reacts to changes in the market with a delay. The specifications are as follows:

$$\overline{\Omega}_{mt}^{x} = \alpha_o + \alpha_1 HHI_{mt-1}^{x} + f_t + u_{mt} \quad (33)$$

$$\overline{\Omega}_{mt}^{x} = \alpha_o + \alpha_1 HHI_{mt-1}^{y} + f_t + u_{mt} \quad (34)$$

where, *x* indicates own industry, *y* indicates the other industry, *m* denotes county, and *t* time. The error term is assumed to be normally distributed with an expected mean of zero and uncorrelated with the explanatory variable.

Table 6.5 The impact of concentration in $t-1$ on weighted average productivity

Dependent variable	Productivity in t		
	Producers	Packers	
Variables	(1)	(2)	(3)
HHI producer t-1	3.472*** (0.333)		1.119*** (0.207)
HHI packer t-1		1.081*** (0.329)	
Year FE	Yes	Yes	Yes
Observations	226	185	185
Constant	Yes	Yes	Yes
Adj. R2	0.319	0.00295	0.0967

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 6.5, specifications (1) and (2) show the effect of own industry concentration in $t-1$ on own industry productivity. The results show that markets with fewer competitors have higher productivity, all else equal. The effect of an increase in concentration on productivity is larger for producers compared to packers. Both coefficients are statistically significant at the one percent level. Specification (3) presents the effect of concentration in $t-1$ in the producers' market on the packers' productivity. The results show that packers who exist in markets where there is a high concentration for producers have a higher productivity, all else equal. The coefficient is statistically significant at the one percent level.

How productivity affects markup. Specification (35) test the impact of the weighted average productivity ($\overline{\Omega}_{mt}^{x}$) in own industry on the weighted average markup ($\bar{\mu}_{mt}^{x}$) in own industry. Specification (36) instead uses the weighted average productivity for producers in $t-1$

($\overline{\Omega}^{y}_{mt-1}$) to explain changes in weighted average markup for packers. Both specifications control for unobserved variables that vary over time but are constant over counties, and variables that vary over counties but not over time.

$$\bar{\mu}^{x}_{mt} = \alpha_0 + \alpha_1 \overline{\Omega}^{x}_{mt} + f_t + f_m + u_{mt} \tag{35}$$

$$\bar{\mu}^{x}_{mt} = \alpha_0 + \alpha_1 \overline{\Omega}^{y}_{mt-1} + f_t + f_m + u_{mt} \tag{36}$$

where, the error term is assumed to be normally distributed with an expected mean of zero and uncorrelated with the explanatory variables.

Table 6.6 The impact of weighted average productivity on weighted average markup

Dependent variable	**Weighted Markup**		
	Producers	**Packers**	
Variables	(1)	(2)	(3)
Productivity producer	0.368***		
	(0.00857)		
Productivity packer		0.350***	
		(0.0181)	
Productivity producer t-1			0.0656*
			(0.0373)
Year FE	Yes	Yes	Yes
County FE	Yes	Yes	Yes
Observations	226	185	128
Constant	Yes	Yes	Yes
Adj. R2	0.957	0.946	0.810

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results from specification (1) in Table 6.6 imply that markets for producers with high productivity have higher markups, all else equal. The same conclusion is valid for packers (2). The coefficients are 0.37 and 0.35 respectively, and they are both statistically significant at the one percent level. Specification (3) shows that packers existing in a market where the producers had high productivity in $t-1$ have higher markups. The coefficient for producer productivity in $t-1$ is 0.07 and statistically significant at the 10 percent level.

How concentration affects markups. Here the impact of concentration in $t-1$ (HHI^{x}_{mt-1}) on markups in t ($\bar{\mu}^{x}_{mt}$) is investigated. This is done by running concentration in own industry in $t-1$ on markups in own industry in *t*, first with year fixed effects, then with county fixed effects, and lastly with both fixed effects. See specifications (37), (38), and (39), and their respective results in Table 6.7

$$\bar{\mu}_{mt}^{x} = \alpha_0 + \alpha_1 HHI_{mt-1}^{x} + f_t + u_{mt} \tag{37}$$

$$\bar{\mu}_{mt}^{x} = \alpha_0 + \alpha_1 HHI_{mt-1}^{x} + f_m + u_{mt} \tag{38}$$

$$\bar{\mu}_{mt}^{x} = \alpha_0 + \alpha_1 HHI_{mt-1}^{x} + f_t + f_m + u_{mt}. \tag{39}$$

The error term in the specifications is assumed to be normally distributed with an expected mean of zero and uncorrelated with the explanatory variables.

Table 6.7 The impact of concentration in *t-1* on markups

Dependent variable	**Weighted Markup**					
	Producers			**Packers**		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
HHI producer t-1	1.291***	-0.0443	-0.164			
	(0.126)	(0.349)	(0.354)			
HHI packer t-1				1.238***	-0.345*	-0.476**
				(0.202)	(0.202)	(0.198)
Year FE	Yes		Yes	Yes		Yes
County FE		Yes	Yes		Yes	Yes
Observations	226	226	226	185	185	185
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R2	0.321	0.515	0.541	0.138	0.786	0.819

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 6.7, specifications (1) and (4) show the impact of an increase in concentration in $t-1$ on weighted average markups in *t*, when only controlling for year fixed effects. For both producers and packers, the results indicate that markets with a high concentration have higher markups. Both coefficients are statistically significant at the one percent level. Although specifications (2) and (5) indicate that when controlling for variation across counties, the relationship between concentration and markup is negative. This relationship holds in (3) and (6) where both year and county fixed effects are controlled for. The coefficient for producers in (3) is not statistically significant, but for packers in (6), the coefficient is statistically significant at the 5 percent level. Finally, when controlling for both fixed effects, a market for packers with low concentration in $t-1$ has higher markups in *t*. When we only control for variables that are constant across counties, but vary over time, the relationship between concentration and markup is positive. On the other hand, when controlling for both fixed effects, we see a negative relationship. Even though the result for producers is not statistically significant, we conclude that there is a negative relationship between concentration in $t-1$ and markups in *t*.

Finally, we test the impact of concentration in $t-1$ for producers on the weighted average markup of packers in time *t*, controlling for year and county fixed effects (see equation 40). The results are presented in Table 6.8. The error term is assumed to be normally distributed with an expected mean of zero and uncorrelated with the explanatory variables

$$\bar{\mu}_{mt}^{x} = \alpha_0 + \alpha_1 HHI_{mt-1}^{y} + f_t + f_m + u_{mt}. \quad (40)$$

Table 6.8 The impact of concentration for producers on markup for packers

Dependent variable	**Weighted Markup**
	Packers
Variables	(7)
HHI producer t-1	-0.0262
	(0.159)
Year FE	Yes
County FE	Yes
Observations	185
Constant	Yes
Adj. R2	0.813

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Here, the coefficient of concentration in $t-1$ for producers is negative, indicating that packers existing in a market with a higher concentration for producers have lower markups. However, the coefficient is not statistically significant.

Discussion about the evolution of markups and concentration at the market level. The results for market-level markups are quite similar to the results at the firm level for both industries. The median producers have had a total increase of 1 percent in markups, while the median markets had a slight decrease in markups (Figure 6.2 and Figure 6.5). The markup for producers in the 75th percentile decreased 1 percent at the firm level, while the market in the 75th percentile had stable markups at the market level. For packers, the median and 75th percentile firms experienced an overall decline. At the market level, the median market had a slight decline and a larger decline in the 75th percentile market.

The results on the concentration and number of firms in the markets for producers and packers point to some potential implications. For producers' markets, we see an increase in concentration in the 25th and 75th percentile markets, and a slight decrease in the median market (Figure 6.3). At the same time, the number of producers active in these markets has increased, which indicates that many of the new producers have entered markets with a concentration around the median. For the packers' markets, there was an increase in concentration for the median market, whereas concentration in the 75th percentile market was at the maximum level for the whole period. At the same time, the number of firms in the median market was stable, while the number of firms in the 75th percentile market had increased slightly. These results indicate that some of the existing firms have gained a larger market share and that the new firms have entered markets without incumbents.

Potential driving forces of markups at market level. We conclude that markets with a higher concentration in $t-1$ have a higher productivity in *t*, which is true for both producers and packers (Table 6.5). The estimated effect is larger in magnitude for producers compared to packers. These findings can be associated with the importance of economies of scale. We find that less competitive markets have a few larger firms that also have higher productivity than firms operating in more competitive markets. Furthermore, one interesting finding is that the relationship between productivity and concentration also holds across industries. A market for packers has a higher productivity if this market also had a high concentration in $t-1$ for producers. Additionally, our results show that markets with high productivity have higher markups, both for producers and packers (Table 6.6). It is worth noting that packers have higher markups in markets where producers had high productivity in the previous year. Finally, we see that markets characterized by a high concentration in $t-1$ have lower markups in *t* (Table 6.7).

To summarize, we find that in markets with high concentration, the productivity is on average higher, and the markup is on average lower compared to markets with low concentration. However, the relationship between concentration and markup for producers is not statistically significant. The finding that markets with high concentration also on average have higher productivity is discussed by Autor et al (2020) in their paper about superstar firms. Autor et al. argues that industries become more concentrated due to high productive firms (superstar firms) that induce more exit and less entry of firms in the absence of innovation. Further Autor et al. (2020) also states that markets with higher concentration and high productivity have higher markups, which we do not find evidence to support in this study.

6.3 Limitations

Our study has some potential limitations that need to be considered. First of all, our market level, counties, may not be entirely correct for large firms. It is a simplification of the real world to state that egg producers and egg packers only trade with firms within their own county. Some firms close to the border of another county are likely to trade with firms over the border. However, after a consultation with the CEO of the Swedish Egg Association, we chose to make our division at the county level, as we believe it is the best choice compared to a division at the municipality or province level, which are 290 and 25, respectively. Furthermore, we believe that our results are trustworthy, since we first compute markups at the firm level, and then aggregate them at the county level. Moreover, our results cannot be used to make any inferences on other food industries in Sweden, as all food supply chains are different.

Our method, in which we estimate a production function and recover markups from the optimization condition for a single input, has been discussed in recent research, stating that it generates too high markups (Basu, 2019). For example, Basu argues that an average markup of 1.61 which De Loecker, Eeckhout and Unger (2020) estimates using our method, is too high. De Loecker and Warzynski (2012) argued, however, that when relying on revenue data, as we do, only the level of markups is affected, and it is still possible to investigate the evolution of markups over time and the correlation between markups and firm-level characteristics. Therefore, we believe that our main focus, to investigate the evolution of markups over time and potential driving forces, can be done using the chosen method, even if the estimated markups would be too high.

7. CONCLUSION

This study investigates the evolution of market power for egg producers and egg packers in Sweden from 2001 to 2019. We compute market concentration and estimate markups to investigate the evolution of market power. Our results show that firm-level markups for egg producers increased between 2002 and 2008, decreased in 2008-2016 and increased after 2016. Markups for packers evolved in a similar pattern as the producers until 2016. From 2016, we see a difference in firm-level markups between the industries, as the markup of producers increased by 9 percent in 2016-2019, while the markup of packers fell by 12 percent. These findings indicate a possible increase in market power for producers from 2016, while the market power of packers potentially decreased.

Our results also show that firms in markets with high concentration have higher productivity and lower markups than firms in markets with low concentration. In addition, we find that increases in productivity have a positive impact on markups, both for producers and packers. Finally, a key finding is that producers' productivity has a positive impact on packers' markup.

Market power is a complex phenomenon, which is difficult to measure. Therefore, we propose further investigations into the relationship between egg producers and egg packers in order to draw more substantiated conclusions about the market power in this industry. Another suggestion is to include food retailers in a future study on the Swedish egg supply chain in order to deepen the understanding of market power in the food industry.

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APPENDIX A

Table 1 Productivity

Variable	Obs	Mean	Std. Dev.	Min	p25	p50	p75	Max
Productivity	1028	4.189	1.675	0.493	2.280	5.048	5.329	6.680
Markup if productivity < 4.2	321	1.614	0.243	0.912	1.472	1.588	1.742	2.528
Markup if productivity > 4.2	707	1.909	0.320	0.862	1.725	1.913	2.110	3.167

Table 2 Total net sales by county in thousand SEK

	Total sales in thousand SEK					
	Producer			**Packer**		
County	2001	2010	2019	2001	2010	2019
Blekinge	7471	11611	15470	4988	17303	33040
Dalarnas	14743	36462	75316	6613	9171	17458
Gotlands	4734	23454	34664	54803	171020	182758
Gävleborgs	7297	15575	14722			
Hallands	63502	117418	179186	10443.25	28013.8	88650.5
Jämtlands	0	0	504	28495	56885	74646.66
Jönköpings	0	0	8508	2040	4670	6783
Kalmar	17769	30433	33755	33778.33	88916	284711.3
Kronobergs	0	4595	41088			5447
Norrbottens		0	2843		0	36925
Skåne	226601	367185	481186	71822.8	92543.34	290258
Stockholms	12179	38632	77793	12754	18824	23404
Södermanlands	13036	32554	60614	10296	16199	23301
Uppsala	24791	32405	50046	5121.5	8966.5	17919.5
Värmlands	0	0	3636			2062
Västerbottens	12726	37840	26119			11892
Västernorrlands	0	6534	10181		4263	5924
Västmanlands	18984	37409	30928		0	0
Västra Götalands	34653	121429	133089	74825.16	112425.6	170002.2
Örebro	4730	6653	102534	0	0	5202
Östergötlands	186392	413589	704463	84224.63	215069.5	477356.9
Total	84769.57	160303.9	194095.8	46796.11	77695.19	153060.7

Notes: The markets with an observation of zero sales are markets with one or more firms in them but these firms do not have any net sales recorded. The markets with missing observations are markets with no firms in them.

Table 3 Labor share and labor productivity by county, year, and type of firm

	Labor Share						Labor Productivity					
	Producer			Packer			Producer			Packer		
County	2001	2010	2019	2001	2010	2019	2001	2010	2019	2001	2010	2019
Blekinge	.208	.151	.196	.127	.127	.145	927	1451	1678	1247	2163	2542
	.004	.003	.145				465	794	1098			
Dalarnas	.24	.09	.046	.123	.097	.174	961	1677	1818	1323	1834	2182
	.179	.004	.053				635	1135	2046			
Gotlands	.096	.109	.077	0	0	.087	682	2118	2509	4567	6108	5077
	.024	.01	.057				55	44	2462			
Gävleborgs	.233	.164	.069				1263	1456	1835			
	.217	.212	.042				1388	1023	1844			
Hallands	.1	.097	.09	.129	.114	.084	1450	2227	3627	1172	2179	3056
	.083	.057	.078	.092	.095	.094	646	990	3539	588	1797	3898
Jämtlands			.706	.167	.044	.026			504	2035	7111	3039
						.045						2853
Jönköpings			.134	.04	.124	.189			2127	680	934	1131
			.092						1366			
Kalmar	.138	.138	.127	.135	.143	.1	1359	1490	1488	1921	2380	4485
	.097	.068	.083	.021	.008	.011	726	600	566	441	69	121
Kronobergs		.072	.095			.147		2298	2720			1362
			.032						951			
Norrbottens			.161			.12			1422		0	3077
Skåne	.133	.086	.093	0	.07	.044	1341	3244	3252	89779	3018	14231
	.113	.068	.09			.016	1001	3441	3810	126966	4268	10236
Stockholms	.652	.144	.241	.254	.205	.26	507	1034	927	911	7574	1381
		.148	.155		.004	.021		1249	1280		10062	32
Södermanlands	.174	.083	.169	.143	.089	.175	884	2744	2160	979	2001	1874
	.084	.055	.129	.071	.125	.157	912	1132	1074	421	45	700
Uppsala	.198	.081	.046	.168	.207	.171	1025	1645	1806	1141	2020	2111
	.097	.072	.058	.014	.07	.022	61	1179	1683	34	351	57
Värmlands			.158			.321			1818			687
Västerbottens	.334	.354	.166			.094	863	1677	1949			3964
	.055	.402	.099				62	1384	555			
Västernorrlands		.069	.177		.194	.219		1777	2156		853	1185
		.097	.249					405	2966			
Västmanlands	.167	.168	.15				1507	1588	2945			
	.084	.036	.091				498	821	2070			
Västra Götalands	.106	.104	.47	.212	.114	.175	1272	2094	2048	1793	320	2903
	.047	.068	1.45	.149	.025	.068	684	1253	1867	1282	1331	2047
Örebro	.352	.485	.203			.089	434	483	3784			2973
	.154	.145	.236				334	178	4111			
Östergötlands	.213	.187	.114	.148	.118	.144	1086	2960	2895	3550	6173	6605
	.207	.257	.132	.149	.107	.14	771	3048	2559	3887	5892	5820

Notes: Table shows the mean labor share and labor productivity together with the standard deviation, shown just below the mean.

Table 4 Persistence in output elasticity

Dependent variable:	**Theta labor**		**Theta capital**	
	Producer	**Packer**	**Producer**	**Packer**
Variables	(1)	(2)	(3)	(4)
Output elasticity labor t-1	0.963***	0.953***		
	(0.0122)	(0.0158)		
Output elasticity capital t-1			0.950***	0.928***
			(0.0122)	(0.0182)
Year FE	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes
Observations	576	283	576	283
Constant	Yes	Yes	Yes	Yes
Adj. R2	0.928	0.970	0.943	0.954

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 demonstrates the persistence of output elasticity of labor and capital. The evolution of the output elasticity of labor and capital follows an AR (1) process. Output elasticity is defined as the percentage change in output from a one percent change in the respective inputs. The persistence of the output elasticity of labor is 96 percent for producers and 95 percent for packers. The persistence of the output elasticity of capital for producers is 95 percent and for packers it is 93 percent. All regressions are controlling for county and year fixed effects.

Table 5 Persistence in concentration and markups

Dependent variables:	HHI	Markup	HHI	Markup
	Producer		Packer	
Variables	(1)	(2)	(3)	(4)
HHI producer t-1	0.746***			
	(0.0384)			
HHI packer t-1			0.637***	
			(0.0482)	
Markup producer t-1		0.371***		
		(0.0733)		
Markup packer t-1				0.391***
				(0.0775)
Year FE	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes
Observations	373	200	299	167
Constant	Yes	Yes	Yes	Yes
Adj. R2	0.843	0.630	0.738	0.840

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

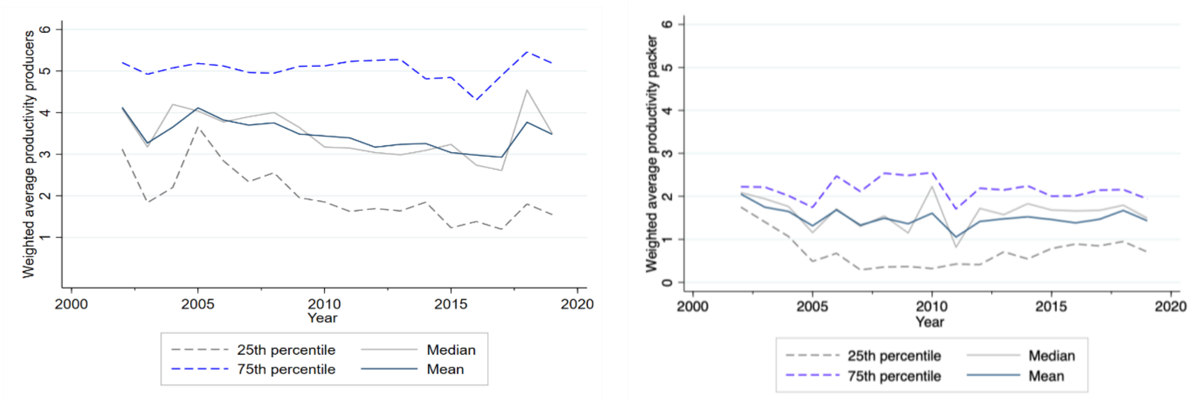

Figure 1 Evolution of weighted average productivity

The packers' productivity is on average lower than the producers' productivity. The interquartile range is also narrower compared to producers, meaning that there is less dispersion in productivity between the markets for packers. In 2016, there was a downturn in productivity followed by a large increase in the whole distribution. Thus, weighted productivity for producers in the average market has decreased over the time period. In 2010 the interquartile range was 0.32 to 2.55, with a median productivity in one market of 2.2. In 2010, there was a large spike of productivity both in the median and 75th percentile market followed by a large decrease in 2011, seen in the right panel of Figure 1.

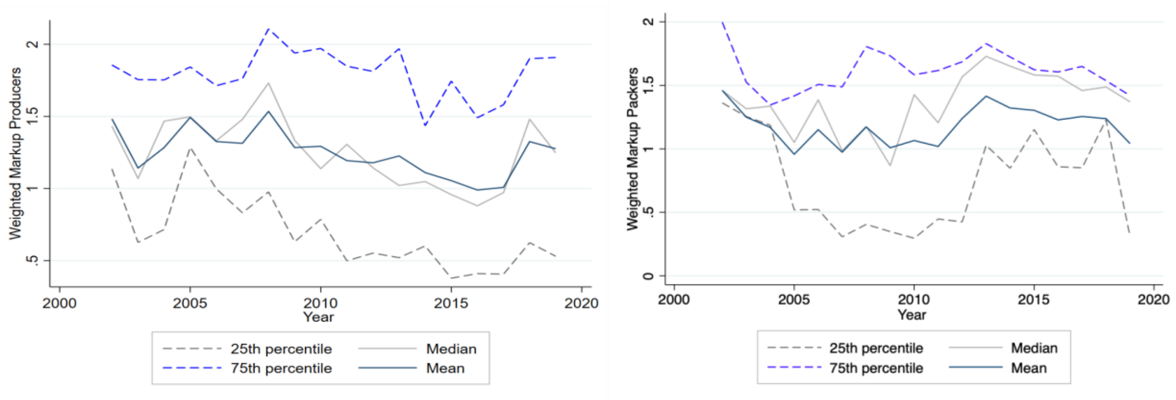

Figure 2 Evolution of weighted mean markup for producers and packers

Figure 2 presents the same results of the evolution of weighted average markup over time as in Figure 6.5, but here the whole period is presented. Thus, the overall patterns which are seen in Figure 2 are mentioned. The different lines in the Figure are representing the 25th percentile, median, 75th percentile and mean markup. As shown in the left panel of Figure 2, the gap between markups for producers in the 25th and the 75h percentile increases slightly from 2005 and forward. From 2007 the values of all of the quartiles including the mean have a decreasing trend until around 2016 where the markup starts to increase again. The time period ends with a decreasing trend in all of the quartiles including the mean.

In the right panel of Figure 2, the quartiles are volatile during the time period. All quartiles have a decreasing trend in the beginning of the period. The gap between the 25th and 75th percentile is small in the beginning of the period and increases from 2005-2011 and goes back to a smaller gap from 2013 and onwards. In the end of the period there is a decreasing trend in the markup for all quartiles.

APPENDIX B

1. Laws on imports. Sweden and Finland have a higher level of safety regulations when it comes to controlling for salmonella and other diseases in hens and eggs (Reg. (EC) 2004/853). The EU-regulations do not override these laws and, for example, packing centers looking to sell eggs on the Swedish market have to comply with the Swedish regulations for testing to detect salmonella. Eggs imported to Sweden require a certificate stating that the test results for salmonella came back negative, even if the exporting country is a member of the EU (Com.

Reg. (EC) 2005/1688). These specific regulations on tests for salmonella do not apply to imported eggs from Denmark, or from other egg packing facilities that have equivalent control programs acknowledged by Sweden and Finland (Swedish Food Agency, 2020).

2. Organic egg production. An organic egg producing farmer has stricter regulations to follow than if producing free range inside eggs or eggs in enriched cages (Swedish Board of Agriculture, n.d). The hens in organic egg production need to have the possibility to be outside in a yard with sand or gravel with trees and branches where the hens can hide. The organic egg production also needs to have a porch which smooths the transition from indoor to outdoor environment for the hens. Hence, a recommendation is that the hens from organic production should spend about a third of their lives outside. The barn needs to be equipped with one third area with poultry litter, perches and a place where they can lay their eggs. There has to be a maximum of six hens per one square meter available area and they need to get organic feed. The increased demand for organic eggs has resulted in that it is more common for conventional egg production to change to organic production (Swedish Board of Agriculture, n.d).

3. The need for laws. In Sweden, there has been a political debate during the last years regarding a prohibition or law for phasing out all of the cages (Riksdagen, 2019). In an in interpellation in the Swedish Riksdag in December 2019 there was a debate where the Minister of agriculture argued that Sweden does not need any law at the moment when it comes to phasing out enriched cages, because the farmers are decreasing this production system anyway because of the increased demand of free-range eggs. The minister presented that there were 32.5 percent hens in enriched cages in Sweden in 2010, whereas this number in 2018 was 9.3 percent. This quick transition has been due to the consumer power where consumers' dissemination of knowledge has increased and the distinct labels, such as organic or free range inside/outside, result in consumers making conscious decisions. This indicates that the consumer demand is affecting the market of production (Riksdagen, 2019).

4. The European Union regulations for egg producers and egg packers. The European Union has put forth laws and regulations regarding the food industry and the trade of food between countries in the EU. These laws aim to standardize the food production and the egg production over the countries, both in marking and hygiene aspects of the production. According to the European Parliament and the Councils regulation (EC) 2004/853 of April 2004 the egg producer is obligated to keep the eggs clean, dry, free of extraneous odor, protected from shocks and out of sunlight before selling them to consumers or packaging companies. Further eggs have to be delivered to the consumer within a maximum of 21 days from the date of laying (Swedish Food Agency, 2020). According to Commission Regulation (EC) 2008/589 of 23 June 2008 eggs have to be marked with the best before date of 28 days after hatching. Eggs in the Swedish grocery stores can only be sold up until 7 days before the best before date. After that they have to be thrown out (Swedish Food Agency, 2020).

5. Company forms. In this section, the different company forms will be explained since we have access to different amounts of data depending on the type of company. The obligations of what type of information each company has to report is determined by the Swedish law.

Our two main types of company forms are limited companies and sole proprietorship. This study includes 488 companies that are sole proprietorships, where 473 of them are producers, 14 are both and one company is a packer. According to the Swedish Companies Registration Office (2012) a sole proprietorship is a company form where there is one sole owner, who is responsible for debts and deals etc. It is not required for a sole proprietorship to submit an annual report to the Swedish Companies Registration Office (Swedish Companies Registration Office, 2012). Limited company is a company form where there are one or more owners, who are not personally liable for the company's financials. A limited company can either be private or public. A limited company is required to file an annual report with the Swedish Companies Registration Office (Swedish Companies Registration Office, 2014a). This study includes 235 limited companies, 191 of these are producers, 15 companies are packers, and 29 companies are both packers and producers.

Partnership companies can be divided into trading and limited partnership. This study includes 17 trading and limited partnerships and all of them are producers. In a limited partnership there must be at least two or more partners, called a general partner and a limited partner (Swedish Companies Registration Office, 2019a). The general partner is personally responsible for the agreements and debts of the company. Similar to a limited partnership a trading partnership must have at least two or more partners. This business type is a legal entity (Swedish Companies Registration Office, 2019a). Although, the partners are personally responsible for all depts in the company (Swedish Companies Registration Office, 2014b). These business types only need to have an auditor if one of the partners is a legal entity or if the partnership has fulfilled at least two criteria’s of being “large” in the last two financial years. The criterions are that the company has an average of 50 or more employees, balance sheet of more than 40 million SEK or a net turnover of more than 80 million SEK (Swedish Companies

Registration Office, 2019a; Swedish Companies Registration Office, 2014b). Furthermore, a trading partnership needs to file an annual report with the Swedish Companies Registration Office with the same premises as with an auditor (Swedish Companies Registration Office, 2019a).

In the study there are 13 producers and 5 both that are partnerships. According to the Swedish Companies Registration Office (2019b) this company type is used if two or more people want to collaborate but do not want to open a trading, limited partnership, or limited company. The partners are responsible for the debts and liabilities of the company. Since a partnership is not a legal entity the company itself is not obliged to file an annual report (Swedish Companies Registration Office, 2019b). The study also includes one producer who is an economic association and one producer who is registered as a non-profit organization.