Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 15, Issue 2, 2015
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE IMPACT OF GOVERNMENT INTERVENTION ON AGRICULTURAL INDUSTRY: A CASE STUDY IN THE ISRAELI RAW MILK INDUSTRY

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Abstract

This research studies the effect of government intervention on the Israeli raw milk industry by examining the relationship between the producers' costs and the price of milk. Like in many other countries, the government is actively involved in the Israeli agricultural market, including the raw milk production industry. The goal of government intervention is to ensure regular production and supply of basic, necessary milk products. Intervention manifests through the setting of production quotas and the price that the dairy farmers receive when selling their milk. According to accepted economic theory, the price that the government is supposed to set is the same one that would arise through a competitive market. The purpose of this research is to study the relationship between the price and marginal cost over two periods. The first period is from the years 1974 through 1994 and the second period is from 2010 through 2012. In the time between these two periods a fundamental change to the industry occurred in terms of the way the government interacted with the farmers. It will be interesting to see if the government policy change has an effect on the relationship between the price of milk and the marginal cost of the dairy farmers. The results of this study show that the price of milk is higher than the marginal cost, but the markup in both periods (1974 to 1994 and 2010 to 2012) is not particularly high.

Key words**:** *government intervention, market power, markup, raw milk*

INTRODUCTION

In a competitive market, the marginal cost is equal to the output price and there is an efficient allocation of resources. However, in a market in which firms have market power, the allocation of resources is not efficient, and therefore the existence of market power must have a damaging effect. Since this hurts public welfare, governments are in the unique position to reduce it. In industries with government imposed quotas, the size of the market power is especially relevant.

If market power exists, then the output prices are higher than the marginal costs. The efficiency of the market is damaged and therefore the government must set the quotas in such a way that the price will be as close as possible to the marginal costs. In the Israeli industry for the production of raw milk, the government sets production quotas. Raw milk is the milk that is milked from the cows, but which has not yet undergone any industrial processes. The purpose of this research is to measure the size of the market power in the raw milk industry in Israel. Measuring market power is done with the assumption of full certainty in the marketplace, but in reality the raw milk producers function with a degree of uncertainty. When there is uncertainty and producers are risk averse, the price should be higher than the marginal costs (in order to compensate for the uncertainty). Therefore, we don't expect that the price will be equal to the marginal costs, but we also don't expect that the difference will be too big (according to criteria which will be discussed in the following sections). The existence of market power can come about from additional economic influences. According to Muller (2006), market power is one of the factors that can influence the price levels, as well as the reaction of the market to the business cycle. [9]

Additional studies, such as Banerjee and Russell (2005), found that there is a connection between market power and inflation. [2]

Bjørnstad and Kalstad (2010) found that

market power can influence wage levels. [3]

A possible measure for market power is "markup." The markup is the ratio of the price to the marginal cost. In perfect competition, the markup is one, and it will increase as the market power of the producer increases. The question this research study seeks to answer is: "what is the size of the markup in the raw milk industry in Israel?"

Measuring the market power of a single firm

At first glance, in order to measure the markup it is enough to check how the manufacturer uses one input. The condition for maximum profit is:

$$\mathbf{MC} = \frac{\mathbf{p_j}}{\mathbf{mp_j}} \quad , \quad j=1,2,...,N \tag{1}$$

where j=1,2,...,N are the variable inputs, p_j is the price of input j and mp_j is the marginal output of input j. The desired markup is given by:

$$\mathbf{M} = \frac{\mathbf{P}}{\mathbf{MC}} \tag{2}$$

where P is the price of one unit of output. From the above equation, the markup is able to be calculated with the help of each one of the variable inputs. In this study we assume that in the dairy farming industry, the most suitable input is the number of cows in the herd.

MATERIALS AND METHODS

The sample we were able to work with in this industry consists of data from 41 collective dairy farms in the northern region of the country. The data was gathered from The Organization of the Dairy Farmers of the Valley Agricultural Center, which operates for the instruction and development for the dairy industry in the northern region of the country. Within this framework the organization gathers detailed data about the larger collective dairy farms which are in the region. The average number of cows per dairy farm is 429, ranging from 241 cows in the smallest dairy farm to 1,107 cows in the largest dairy farm. The database does not include information about the family dairy farms whose herd size stands at only a few tens of cows. Because of the need to calculate the differences over the years, the regression requires data over at least three years. Similarly, the data for the fertility rate is supposed to be for the previous year, and therefore we need information for one additional year. The three years over which the study was done were the years 2010 – 2012.

Calculating the markup: Many studies have attempted to measure market power with the help of the markup. Hall (1988) calculated the markup by dividing the "elasticity of production with respect to work" by the labor share. Abbott, Griliches & Hausman (1988) and Eden & Griliches (1993) added the utilization rate of the labor to the regression which estimated the elasticity of. [1, 6]

Domowitz, Hubard & Petersen (1988) repeated the technique of Hall by using the raw materials inputs instead of labor inputs. [5]

In all of these studies there is the problem of having to estimate the production function.

A different group of researchers tried to avoid the need to estimate the production function. There is usually available data about the state of the market (such as prices and amounts), as well as on exogenous variables that can influence the firms expenditures. Bresnahan (1989) pored over studies that were done according to the above conditions. [4]

An interesting development in the aforementioned technique appears in a study by Finkelstein & Kachel (1996) who used data on the marketing of agricultural products for two separate markets in order to estimate the market power of the agricultural industry in Israel. [7]

In this study we will estimate the market power of the raw milk producers by estimating the markup using a technique based on Hall (1988) [8], whereby the markup is:

$$\mathbf{M} = \frac{\mathbf{P}}{\mathbf{MC}} \tag{3}$$

We will see that the markup can be estimated by dividing the "production elasticity with respect to any factor" by "the share of this factor in the final sale". In this study the production factor that we will use in order to

calculate the market power is the number of cows, which will be denoted by K. Specifically, we will define the production elasticity with respect to the number of cows by:

$$\beta_k = \frac{\Delta V/V}{\Delta K/K}, \quad (4)$$

where V is the output (which will be defined more precisely later). In addition, we will use Sk to denote the proportion of the cows at redemption, which is calculated as follows:

$$\mathrm{Sk} = \frac{\mathrm{r} * \mathrm{K}}{\mathrm{P} * \mathrm{V}}, \quad (5)$$

whereby r is the annual cost of a cow. This calculation will also be further defined later. With the help of the above definition we can see that:

$$\frac{\beta_k}{Sk} = \frac{\frac{\Delta V/V}{\Delta K/K}}{\frac{r*K}{P*V}} = \frac{P}{\frac{r}{\Delta V/\Delta K}} \quad (6)$$

The expression $\frac{\Delta \mathrm{V}}{\Delta \mathrm{K}}$ is the marginal output. Therefore

$$\frac{\mathrm{r}}{\Delta \mathrm{V}/\Delta \mathrm{K}} = \mathrm{MC} \quad (7)$$

If we substitute (7) into (6) we get

$$\frac{\beta_k}{\mathrm{Sk}} = \frac{\mathrm{P}}{\mathrm{MC}} = \mathrm{M} \quad (8)$$

The dairy farming industry: The dairy farming industry in Israel functions by way of government planning. There are a few implications:

1.All the raw milk is marketed in a centralized way.

2.Each farmer has a fixed manufacturing quota.

3.At any time, the price which the farmers receive for their milk is constant and known in advance.

4.When there is a need to change the price of raw milk because of changes in the input prices, the matter is addressed by the government representatives.

In order to see the motivation for checking the markup in this industry, let us recall an article by Stigler (1971), which dealt with a situation in which a cartel develops due to government involvement. [13]

Stigler's basic assumption says that government intervention in certain industries derives from political considerations, and not from economic or social ones. In accordance with this method, the political party in power takes administrative steps (like granting subsidies, rationing production quotas, limiting imports, etc.) which enable the industry to accumulate market power, and in exchange the firms which operate in that industry grant the political party political support that is expressed as voting during elections, helping with organization, and financial contributions to campaigns. Against this approach is the claim that the goal of government intervention in industries such as the raw milk industry is the guarantee of regular availability of essential dairy products. In this case the government is supposed to set the prices in accordance with what they would be in a free market. Under conditions of market certainty the markup will be one.

In addition, under conditions of inflation it is necessary to update, from time to time, the price of raw milk. Seemingly, this is a simple matter that can be done by indexing the price of raw milk to an inflation index. The problem is that the index must be the input costs for the industry, and there could be controversy regarding the index as to changes in the prices of the inputs, or as to the makeup of the industry input basket. Therefore the updating is done by way of negotiations between representatives of the dairy farmers and the government.

The production function of raw milk:

The dependent variable – the value of the raw milk (denoted as V):

The output of the dairy farming industry is not measured only by the amount of milk, but also by the percent of fat and amount of protein it contains since the higher the fat percentage and protein content are, the better the price the farmer gets for the milk. However, there is a trade-off between the percentage of fat and the amount of milk: the more the dairy farmer increases the percentage of fat in the milk (by way of altering the diet), the less milk there is. Therefore we need to weight the amount of milk with the amount of fat. The best way to do this is by using the price of milk because, from the perspective of the producer, the

effect of the fat percentage on his income is what matters. In order to calculate this weighted average we divide the price that each producer receives in each year by the average price of milk for that year. If $\bar{p}_t$ is the average price of the whole industry in year *t*, and p_t^n is the average price of producer *n* in year *t*, then by multiplying $p_t^n/\bar{p}_t$ by the amount of milk that farmer *n* in year *t* produced, we get the weighted amount of raw milk, in terms of its price.

The inputs

A.The number of cows (denoted as K): includes the cows which gave milk in the same period (and therefore does not include calves and cows about to give birth).

B.Cost of food per cow (denoted as F): The cow like a machine that receives food as an input and yields milk. An increase in the amount of food will increase the amount of milk which the cow gives. Measuring the amount of food is a problematic subject because there are many types of food and each one has a different value. Therefore the measurement of a unit of weight or volume isn't relevant. For example, for 100 grams of a concentrated food –"mixture" there is more nutrition than 500 grams of hay or 1,000 grams of straw). For this reason, the food was measure by the amount of money that the dairy farmers spent on their purchases. This measure is based on the assumption that the dairy farmers operate efficiently, whereby the cost of food increases with the quality, or as the optimal amount increases.

C.Labor costs per cow (denoted as L): If the cow is managed in an efficient manner, a larger amount of labor is considered to result in better care for the cows, which should increase the amount of milk.

D.The fertility rate of the previous year (denoted as Z): This variable shows the rate at which the cows became impregnated during the course of the previous year. Immediately after the birth, cows give their maximum amount of milk, and after a few months the amount of milk begins to fall.

Therefore, the dairy farmers try to impregnate the cow (that is, to cause them to become pregnant), as soon as possible.

During the pregnancy the cow continues to give milk until a few weeks before the birth, so the dairy farmers "dry out the cow" by not milking her in order to allow her to rest. After the birth the regular process resumes. Impregnating the cows is no simple matter and requires taking a few steps, which carries a cost. Therefore, we can address the issue of fertilization (which is the percentage of cows that were impregnated in the same year) as a type of input. It takes nine months from the time of impregnation until birth, and therefore the fertilization affects the output of the next year. For this reason, last year's fertility rate appears in the production function.

E.Breeding (denoted by e^{τ}): One of the characteristics which stands out in the Israeli raw milk industry is the cultivation of the genetic material of the cowherds. The cultivation is done in two steps:

(i)Strict selection of the fathers: since most of the cow inseminations in Israel are artificial, a few tens of bulls are enough to inseminate all the cows in the country.

Therefore, it is possible (and highly recommended) to invest great effort, in order to ensure that the bulls are the best available. These bulls are chosen, firstly, according to the quality of their mothers, and then there is an additional selection process according to the quality of their daughters.

(ii)Choosing the calves: not all calves which are born in a dairy farm are raised to be dairy cows (with the rest sold for meat). When the dairy farmers choose the calves which they intend to raise, they consider the quality of their mothers.

As a result of both of these actions, there is a process which improves the quality of the cows which is expressed as an increase in the quantity of milk.

This increase occurs at a fixed rate, and therefore we can express the trend using the variable e^{τ} where τ takes a value of 1 for the first period, a 2 for the second, etc.

Conclusion: The production function for the dairy farm industry is:

(9) $$V = e^{\alpha}(e^{\tau})^{\beta_\tau} K^{\beta_k} F^{\beta_f} L^{\beta_L} Z^{\beta_z}.$$

A logarithmic transformation of the

production function yields the following equation:

(10) $\ln(v) = \alpha_n + \beta_\tau \ln(\tau) + \beta_k \ln(K) + \beta_f \ln(F) + \beta_L \ln(L) + \beta_z \ln(Z) + \varepsilon$

If we take the first differences of ln over time, we get:

(11) $dv = \beta_\tau + \beta_k dk + \beta_f df + \beta_L dl + \beta_z dz + \varepsilon$

where $dx_t = \ln(X_t) - \ln(X_{t-1})$

The reason for using the differences across time is to eliminate α_n. In addition, as we previously defined, the variable τ increases in value each year by 1. Therefore, if we take the difference between the years, this variable disappears and we are left with its coefficient β_τ.

In order to perform the check, we will recall, that from equation (8) we get:

(12) $\beta_k = M \cdot Sk$

If we substitute β_k into equation (11) we get:

(13)

$$dv = \beta_\tau + M*(Sk*dk) + \beta_f df + \beta_L dl + \beta_z dz + \varepsilon$$

In this equation the second independent variable is the product of *Sk*, *dk*, and the coefficient *M*, is the required markup.

Noise in the regression: The cows are, perhaps surprisingly, very sensitive as a production factor. Therefore, each "malfunction" in care has the possibility of causing heavy damage. For example, the cows are fed a number of times each day at fixed hours. A delay in feeding time has an immediate, negative impact on the amount of milk the cow will produce. Another example: the wrong care at the time of milking also translates into an immediate loss of milk as well as long term damages. During the day to day operations there are many setbacks, of which some are caused by external factors such as problems with the tractors or problems with the milking machines, and some are caused by human error. Since we are unable to put these setbacks into our production function, they appear as noise in the regression. These setbacks are not connected to any of the independent variables in the regression and therefore we can assume that the noise of the regression and the independent variables are independent of one another.

RESULTS AND DISCUSSIONS

As stated above the formula for calculating Sk is $Sk = \frac{r * K}{P * V}$. To calculate this variable we need the following information:

- $P * V$ – The total annual revenue for all the dairy farms in the sample. In 2012 this was 438,138,258 NIS.
- K – The number of cows in all the dairy farms in the sample. In 2012 there were 17,597 cows.
- r – The price of K. This is the annual cost of a milk giving cow. The average lifespan of a cow in the herd is five years, however a cow only begins to give milk in the third year of its life, rendering its economic life only three years.

The annual cost of a milk cow (the size of r) is made up of three components:

(1)The cost of a new cow that joins the herd and begins to give milk: The dairy farmers can purchase new cows, but usually they prefer to birth and raise their own calves by themselves. Raising a calf from birth until it begins to give milk (and becomes a "milk cow") takes two years. The average cost in 2012 was ₪9,280. However, we are interested in the average annual cost of a milk cow. Therefore the cost to raise a cow for one milking year is ₪3,093 (which we get by dividing the cost to raise the calf by three).

(2)The annual cost of food and additional costs for a milk cow: In 2012 this cost was ₪14,000.

(3)The money made from the sale of cows for meat: When a cow reaches the end of its life it is sold to meat producers. The money received from the sales of meat offsets some of the costs of keeping the dairy cow and therefore it must be deducted from the other two amounts. The average receipt for selling a cow for meat in 2012 was ₪4,591. We arrive at the annual income received from selling

meat by dividing the above amount by three, which gives us ₪1,530.

The sum of these three amounts show that in 2012, r = 15,564 and Sk = 0.625.

The market power size: The results of the regression of equation (13) appear in the table below:

Table 1. Regression results and the size of the markup

Variable	Coefficient
Sk*K	1.297
Cost of food for one cow	0.3
Adjusted R-squared	0.72

As can be seen from the table, the size of the markup is 1.297 which means that the price of the final product is higher than the marginal cost. Sandmo's (1971) argument states that the absence of market power must lead to parity between the marginal cost and the price, but only if the market conditions are known with certainty or, alternatively, that the producer is indifferent to risk. [10]

If there is uncertainty regarding the price of the output, the prices of the inputs, or the amount of output, then risk aversion will result in a decrease in the optimal output for the producers. From here it follows that if there is uncertainty in a system, with risk averse producers, then even if the producers do not have market power, the expected price will be greater than the (sum of the) marginal costs, and the markup will be greater than one. Therefore, from the above discussion, in order to determine if the dairy farmers of Israel have a lot of market power (which would require a decrease in the price of raw milk), we need to compare the markup here with the markups of other industries.

In a study by Shahor (2011) which looked at the markup in the Israeli banana industry, he found that the markup stands at around 1.92. [11]

Therefore when compared to the banana industry we can see that the market power of the dairy farmers in Israel is not particularly large. However, we need to remember that in the banana industry the level of risk is much greater and therefore the risk premium in the banana industry is much greater. We can conclude by saying that for the Israeli dairy industry there is some sort of market power, but in order to determine if it is too much, and in order to properly phrase a recommendation as per the required government policy, further research in other industries of similar risk to the dairy industry must be conducted. Alternatively, one could calculate the relevant risk premium for this industry.

In a Previous study by Shahor (1995) which looked at the markup in the Israeli raw milk industry during the years 1974-1994 he found that the markup stands at around 1.25. [12]

As you can see, despite the many changes that occurred over the years, No significant change has occurred in the market power of this industry.

CONCLUSIONS

In this research study we checked the market power of the raw milk producers in Israel. We measured the market power using the markup, which we calculated by dividing the output price by the marginal costs. The raw milk producing industry is particularly interesting because the price of milk the producers receive is set by the government. The price the government is supposed to set in situations such as this is the price that would result in a free market. Under conditions of absolute certainty or indifference to risk, this price must be equal to the marginal costs, and the markup should be equal to one. If, on the other hand, there is uncertainty in the production system (which is what always happens in reality) and the producers are risk averse, the producers add to the price of the product a risk premium. Therefore, even under free market conditions, the markup will be greater than one. The results of the study suggest that the markup of the raw milk production industry is 1.29, which of course is greater than one.

In comparison with the banana industry, whose markup was measured to be 1.92 in the past, it can be seen that in the Israeli raw milk production industry there is a degree of market power held by the producers. However, in order to determine its strength there is a need for further research about the

markup in other industries with similar risk. An alternative would be to estimate the relevant market premium in the raw milk industry. As stated above, a study that examined the markap in 1974 to 1994 found similar results. These aforementioned things can show that, the intervention of the government in the raw milk industry does not derive only from the relationship of the producers and the political system, as Stigler claimed.

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