Sveriges lantbruksuniversitet
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Department of Economics

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- How was it affected by the MRSA-outbreaks in Denmark?

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SLU
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Abstract

Sweden is a large importer of Danish pork. Roughly one third of the total import of pork to Sweden is Danish pork. During 2014 media uncovered that 9 out of 10 Danish pigs carries the MRSA-bacteria. This thesis researches how the outbreaks of the MRSA-bacteria in Danish pig stables affected the demand for pork in Sweden. . It will treat economic and econometric theory such as the log-log model and the Armington model. The topic will be researched with the help of data from different databases such as Eurostat and Statistics Sweden. Methods will be applied based on the theory in the purpose of finding structural change in the data set. The results from the methods showed a significant indicator for structural change due to the MRSA-outbreak and that the demand for pork in Sweden has changed because of it.

Keywords: Armington model, demand, log-log model, MRSA, pigs, pork

Sammanfattning

Sverige importerar stora mängder danskt fläsk. Ungefär en tredjedel utav den totala fläskimporten består av danskt fläsk. Under 2014 avslöjade media att 9 av 10 danska grisar är smittade med den antibiotika resistenta bakterien MRSA. Den här uppsatsen kommer att undersöka hur MRSA-utbrotten I Danmark påverkat efterfrågan på fläsk I Sverige. Den kommer att behandla ekonomisk och ekonometrisk teori såsom log-log-modellen och Armington modellen. Ämnet kommer att undersökas med hjälp av data från olika databaser såsom Eurostat och Statistiska centralbyrån. Metoderna som kommer att tillämpas på baserade på teorin i syfte att hitta strukturella förändringar i datamängden. Resultaten från de metoder som användes visade en signifikant indikator för strukturella förändringar på grund av MRSA-utbrottet och att efterfrågan på griskött i Sverige har förändrats på grund av det.

Nyckelord : Armington model, demand, log-log model, MRSA, pigs, pork,

Abbreviations

MRSA	Meticillin resistent *Staphylococcus aureus*
MRS	Marginal rate of substitution
MU	Marginal utility

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1 Introduction

Sweden is a large importer of Danish pork. Roughly one third of the total import of pork to Sweden is Danish pork (Jordbruksverket, 2014). Due to extensive over use of antibiotics in the pig production to favor and stimulate a fast growth rate of the pigs a bacteria evolved that is resistant to antibiotics, the MRSA-bacteria.

During May 2014 media revealed that outbreaks of MRSA-bacteria in Danish pig stables were very common. 9 out of 10 pigs carrys the MRSA-bacteria in Denmark and 4 people have died from this bacteria since 2012 (Jordbruksaktuellt, 2014-05-19). This caused huge media attention and a concern for consuming pork. Media investigated this thoroughly and found that not only Danish pork in Swedish grocery stores were contaminated with MRSA-bacteria but German pork as well (Dagens Nyheter, 2014-11-13). Germany is the largest exporter of pork to Sweden and Denmark is the second largest. Together they represent about three fourths of the imported pork to Sweden (Jordbruksverket, 2014). Food safety concerns arose that meat contaminated with MRSA-bacteria could result in that the consumer could get infected with the MRSA-bacteria from handling and eating the meat. Swedish Livsmedelsverket (2014) dismissed these rumors but all the media attention still made the Swedish consumer more aware of food and how it is produced.

This food safety scandal that was blown up by media raises the question of "how did the MRSA-outbreak in Danish pig stables affect the consumption of pork in Sweden?" That in its own turn raises the question of "who were the benefiters from the outbreaks and who were losers and also if we still can see effects from the MRSA-bacteria outbreaks in 2014 in the market?"

1.1 Purpose and data

The ambition of this thesis is to research how the Swedish demand for domestic and Danish pork was affected by MRSA-bacteria outbreaks with the help of an economic model and analyzing data with econometrics. The data will be limited to the consumer's average income, prices for pork that will be computed from consumer price index. Data over the quantities of meat imported to Sweden, the quantities of meat exported from and the quantities of meat produced in Sweden.

1.2 Prior Research and outline

There has been a lot of prior research in how food security and food scandals affect the demand for meat. During the mid-nineties and early 00´s there was extensive research on how *Bovine Spongiform Encephalyopathy* (BSE) or mad cow decease affected demand for beef. There have also been a lot of studies on how avian bird flu has affected the demand for poultry. Mad cow decease outbreaks and avian bird flu outbreaks have a lot of similarities to the outbreaks of MRSA-bacteria in Denmark. Since these areas have been investigated before there are a lot of studies that can help to further understand how the MRSA-outbreaks affect the demand for pork. For example Peterson and Chen (2005) studied how BSE impacted on demand for beef in Japan between the years of 1994 and 2002. In the study they researched the demand for Wagyu beef an exclusive domestic beef, regular domestic beef and imported beef. The results showed that there was a two-month transitional period before the demand was affected by the food scare. They could also show that the scare affected all types of beef.

Okrent and Alston (2011) have done a comprehensive study where they thoroughly investigate how demand for food in the U.S. is affected by different factors. In this study they include demand theory, demand models, they discuss other issues that makes estimation of demand for food difficult, and they estimate elasticity's from monthly and annual data. This study will help to understand what parameters are important for the research I intend to do.

A study by Tonsor et al. (2011) examines how animal welfare information provided by media affects demand for beef, pork and poultry in USA. Their result suggests that food safety concerns have a small but significant effect on the demand for meat. Demand for pork and poultry decreased in the long-run as a result of media attention on the food production, however demand for beef were not directly impacted. The loss in consumer demand were more likely due to consumers leaving the meat complex rather than consumers switching to other meat and increasing the demand for substitute meat. A similar study by Pigott and Marsh (2004) suggests that changes in the demand for meat are more likely because of changes in price than because of food security issues. Although they found that food safety events such as food scandals have a significant effect on the demand for meat these are most likely short-lived.

The study by Moschini and Meilke (1989) could be helpful in understanding how changes in demand for meat and the meat market occour. They researched the consumption patterns of meat in the U.S by investigating if structural change had occurred. They found that chicken and fish had been affected by structural change and that during the mid 70:ies the demand curves for chicken and fish had changed.

Another study that can give insight to the research is a study by Surry, Herrard and Le Roux (2002) that applies the Armington model to explain how trade flows of imported and domestic processed food products. Of course the original paper by Armington (1969) will also be reviewed to help understand the model it self.

All of these studies will be helpful to the research that is intended and will help to understand how to research this topic. The models they have used may serve as good templates or patterns for the models that will be used in this thesis. Regarding how much research there has been done on how MRSA-bacteria outbreaks effect on the consumption demand for pork is to my extent very limited if any.

The outline of this thesis will be divided up into five sections. The next one, section two will treat economic theory that is significant for this sort of economic problem. Section three will deal with the estimation methods chosen based on the second section. The fourth section will present the econometric results from the economic models. Lastly the fifth section concludes what the results show and provides a discussion.

2 Theory

Demand theory analyzes the behavior of an individual who gains utility or satisfaction from consuming goods and services given a limited budget. It assumes that the individual has complete information of the goods and services and can therefore make a rational decision on which bundle of goods and services that will maximize the individual's utility within the restraints of the budget. This traditional model of consumer behavior is what provides the basis or foundation for developing models of demand (Okrent and Alston, 2011).

To analyze how the MRSA-outbreaks in Danish pig stables affected the demand for pork in Sweden one will need to look at the demand for pork in Sweden over time and the imported quantities originating in Denmark.

2.1 Single equation model and time siries regression

To do a regression analysis on the demand for pork in Sweden time series data is very helpful. It shows how the demand for pork has changed over time. Since Demand is correlated to the price of the good demanded and to the income or the budget constraint of the consumer a typical model for demand would look as follows:

$$Y=\alpha_0 -\beta_1 x_1 +\beta_2 x_2 \qquad (1)$$

where Y is demanded quantity, x_1 is the price of the good demanded and x_2 is the consumer's income. β_1 and β_2 are the coefficients of how much a change in the price or the budget would affect the demanded quantity. If we add a substitute good much like Danish pork is a substitute for Swedish pork one would get a model looking like this:

$$Y=\alpha_0 -\beta_1 x_1 +\beta_2 x_2 +\beta_3 x_3 \qquad (2)$$

X_3 represents the price of Danish pork and β_3 the coefficient of how much it affects the price. Y would in this case be the demanded quantity of Swedish pork, x_1 the price of Swedish pork, x_2 the consumer budget constraint, β_1 β_2 their respective coefficients. This gives us the basic insights that the price of the demanded good has a negative effect on the quantity demanded, the price of the substitute has a positive effect on the quantity demanded, and the restraint of the budget has a positive effect. (Pindyck and Rubenfeld, 2005)

2.2 Dummy variables

The MRSA-outbreak in Denmark is the sort of event that typically changes the parameters of the explaining economic model. This is often referred to as structural change. Structural change means that at least one of the values of the variables in the model change and do not remain the same during the whole time period. One way to check for structural change is with the use of a dummy variable.

A Dummy variable is a qualitative variable such as race, sex, a month or certain time period and can either take the value of 1 or 0. For the dummy to be an indicator of structural change it will have the

value of 0 until the event that is suspected to be responsible for the structural change occurred and then the value of 1.

$$Y=\alpha_0 -\beta_1 x_1 +\beta_2 x_2 +\beta_3 x_3 +\alpha_1 D_1 \qquad (3)$$

In this case the dummy variable will have the value of 0 for all observations until 2014-04 where it will take the value of 1 until the end of the sample. This will divide the data set and the regression will find if the values of the variables are different in the two periods of the time series

Another way of using dummy variables is to take seasonal trends into account. Seasonal trends or seasonality are common in time series containing monthly or quarterly data, increased demand for ice cream during summer or ham for Christmas etc. Often it's preferable to remove these seasonal effects so that one can concentrate on the other components of the regression. This is called seasonal adjustment and the time series obtained from this is therefore seasonally adjusted. To do this one assigns the dummy 1 during the time period affected by seasonality. In a monthly time series dataset one could assign one dummy for each month thus getting twelve dummies with the value of 1 on their respective month and the value of 0 on all the other months. (Gujarati, 2008)

2.3 Lag

Lag is something that often is used in econometric analysis on time series to research how a variable in the short run or long run affects a dependent variable. A change in the variable may take some time before its noticeable in the dependent variable. This time period is what is called a *lag*. Accordingly the change in the dependent variable is related to the change in the variable that happened earlier in time. Therefore one can create a variable that is shifted forward in time as much as the time period or lag it takes for the changes to affect the dependent variable. The coefficient of which will become the long-run multiplier

$$Y=\alpha_0 -\beta_1 x_1 +\beta_2 x_2 +\beta_3 x_3 +\alpha_1 D_1 +\beta Y_{(t-n)} \qquad (4)$$

(Gujarati, 2008)

2.4 Elasticity and the log-log model

Elasticities are a way to calculate how a change in price, income or the change in price for a substitute good affects the demand of a good.

By calculating the elasticity one measures the sensitivity of one variable to another. It tells us the percentage change that will occur in one variable in response to a 1-percent change in another variable. Elasticity can be written as follows:

$$\varepsilon=(dx_1/dx_2)(x_2/x_1) \qquad (5)$$

There is no reason to expect elasticity's of demand to be constant. Nevertheless it is often useful to work with the isoelastic demand curve. When written in its logarithmic form it appears as follows: (Pindyck and Rubenfeld, 2005)

$$ln(Y)=\alpha+\beta\, ln(x) \qquad (6)$$

This model measures the elasticity of Y with respect x. If Y represents the quantity of a good that is demanded and x represents the price per unit of the good, β measures the price elasticity of demand. This is in econometrics referred to as the log-log model.

The log-log model is of course very useful when estimating the demand for a good since it will give the percentage change in demand for the good due to the change in the variables included in the model. Another advantage the log-log model has is that it makes nonlinear models linear and more easily handled. The log-log model can with ease be applied to a demand model such as the demand for pork in Sweden after the MRSA-outbreak in Denmark. (Gujarati, 2008)

2.5 The Armington model

Developed by Armington in 1969 this model aims to explain a country's imports. The model relies on two assumptions. The first assumption is that traded goods are not homogeneous and differentiated according to their geographical origin. The second assumption is that there is an imperfect substitution between imported and domestically produced goods in the model. This imperfect substitution is measured by a constant elasticity of substitution, σ.

The model assumes that the consumer has a global utility, U that can be satisfied by several different goods, this could for example be beef or pork. At this first step the consumer maximizes his or her utility and chooses the good that maximizes his or her utillity. In a second stage the consumer faces the choice of choosing a domestically produced good or an imported good.

This second decision stage can easily be applied to this case were the consumer faces a decision of choosing between domestic pork and choosing imported Danish pork. Assume that the consumer demands a good *"q"*. The consumer can either consume domestic q_D or foreign q_F. This good *"q"* will give a certain level of utility to the consumer, U_1. The first derivative of q_D and q_F will give the marginal utility, MU of each of the different goods. If we divide MUq_D over MUq_F we get the marginal rate of substitution, MRS of q_F for q_D. In other words how many q_F are one q_D worth. As we move along the indifference curve the quantities consumed of q_D and q_F will change as the MRS is changing. The change in q_D and q_F or substitutability is what's called the elasticity of substitution. Basically it's a measure for how much the ratio of q_D over q_F changes as the MRS changes. I other words the elasticity of substitution is the relative change in the ratio of q_D over q_F resulting from a relative change in the MRS. (Surry et al, 2002)

Moving on we can set up utility function in this case a constant elasticity of substitution function, a C.E.S function. If we set the C.E.S function in subject to a budget restriction we can set up lagrangian.

$$MaxU_1 = A[\beta q_D^{-\alpha} + (1-\beta) q_F^{-\alpha}]^{-1/\alpha} \qquad (7)$$

subject to:

$$p_D\, q_D + p_F\, q_F = R_1 \qquad (8)$$

$$L = A[\beta q_D^{-\alpha} + (1-\beta)q_F^{-\alpha}]^{-1/\alpha}\lambda(R_1 - p_D q_D - p_F q_F) \quad (9)$$

Where β is positive and $\alpha \geq -1$. The elasticity of substitution is $1/\alpha + 1 = \sigma$.
From the Lagrangian we can solve for the first order conditions.

$$\frac{\partial \mathcal{L}}{\partial q_D} = A\beta q_D^{-(\alpha+1)}[\beta q_D^{-\alpha} + (1-\beta)q_F^{-\alpha}]^{-(\frac{1}{\alpha}+1)} - \lambda p_D = 0 \quad (10a)$$

and

$$\frac{\partial \mathcal{L}}{\partial q_F} = A(1-\beta)q_F^{-(\alpha+1)}[\beta q_D^{-\alpha} + (1-\beta)q_F^{-\alpha}]^{-(\frac{1}{\alpha}+1)} - \lambda p_F = 0 \quad (10b)$$

These will then be divided dL/dq_D by dL/dq_F to get the MRS.

$$\frac{\beta q_D^{-(\alpha+1)}}{(1-\beta)q_F^{-(\alpha+1)}} = \frac{p_D}{p_F} \quad (11)$$

If we rearrange this expression we can get the following:

$$\frac{q_D}{q_F} = \left[\frac{(1-\beta)p_D}{\beta p_F}\right]^{\frac{-1}{\alpha+1}} \quad (12)$$

This expression tells us how the changes in the ratio of q_D over q_F is explained by changes in the ratio of p_D over p_F. As shown the expression is a nonlinear expression. To make it more easily interpreted it can just as with the single equation model be written in logarithmic form. Like this:

$$(13) \quad \frac{q_D}{q_F} = -\sigma ln \frac{(1-\beta)}{\beta}\left[\frac{p_D}{p_F}\right]$$

The expression that is obtained will tell how a change in the prices for q_D or q_F affects the demand for the input variables q_D and q_F.

(Surry et al, 2002)

3 Method

The following section will explain the data where it was retrieved and how it's been processed. It will also explain what methods were chosen for the analysis and why.

3.1 Data

The data have been retrieved from Eurostat, Statistiska Central Byrån (SCB) and Jordbruksverkets (Swedish Ministry of Agriculture) databases. The data set contains observations on quantities of pig meat produced in Sweden (Jordbruksverket, a), quantities of pork exported from Sweden (Jordbruksverket, b), and quantities of Danish pig meat imported to Sweden, (Eurostat, a) all in the unit of tons. The Danish import is also measured in value, millions of euro (Eurostat, b). This is then calculated into the import price for Danish pig meat, value divided by quantity. Prices for Swedish pig meat are computed from the producer prices (Jordbruksverket, c). Some assumptions had to be made to get retail prices for pork. Retail prices for Swedish pork were estimated to grow six times the producer price. Retail price for the Danish pork however were only estimated to double the price of imports. The assumptions are different because the domestic meat hasn't had the same progress along the supply chain as the imported Danish meat has. Both of the assumptions seem to be taken out of thin air but the assumptions are supposed to mimic the average real retail prices of today.

Consumer price index for meat (Jordbruksverket, d) was retrieved to make sure that prices and disposable income in the model are real and not nominal. The disposable income per capita is calculated through the household's disposable income (SCB, a) divided by the average amount of persons in the household where an assumption was made that during 2014 there were 1.98 people living in each household on average (SCB, b) and the population of Sweden (SCB, c) then divides this.

The first thing one needs to do when analyzing time series data is to plot the data into diagrams and visually look at the data set. In doing so we can gain important information that could tell us how to proceed and what methods to use when analyzing how demand for pork in Sweden was affected by the MRSA-bacteria in Danish pig stables.

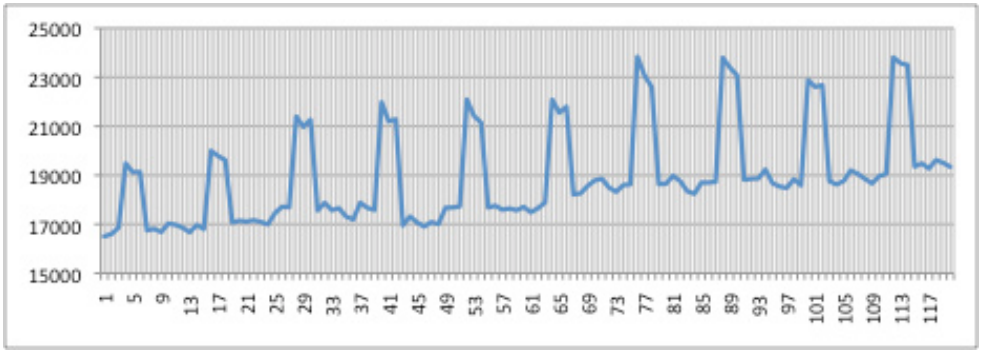

Figure 1. Shows the disposable income per capita divided by the consumer price index

When we look at figure 1 we gain insights such as seasonality in the data. The disposable income per capita clearly suffers from seasonality. The y-axis shows SEK and the x-axis time

Figure 2 shows the trends for pork imported from Denmark denoted as *Qiton*, pork produced and sold in Sweden denoted as *Qdton*. Theese two added together gives us the supply of Swedish and Danish pork denoted as Supplyton.

When we look at the data in Figure 2 one can suspect that the total supply of pork is affected by this large increase in disposable income per capita. However this is not totally clear in figure 2. A last conclusion we can draw from figure 2 is the decrease of imports of Danish pork from 2014-04.

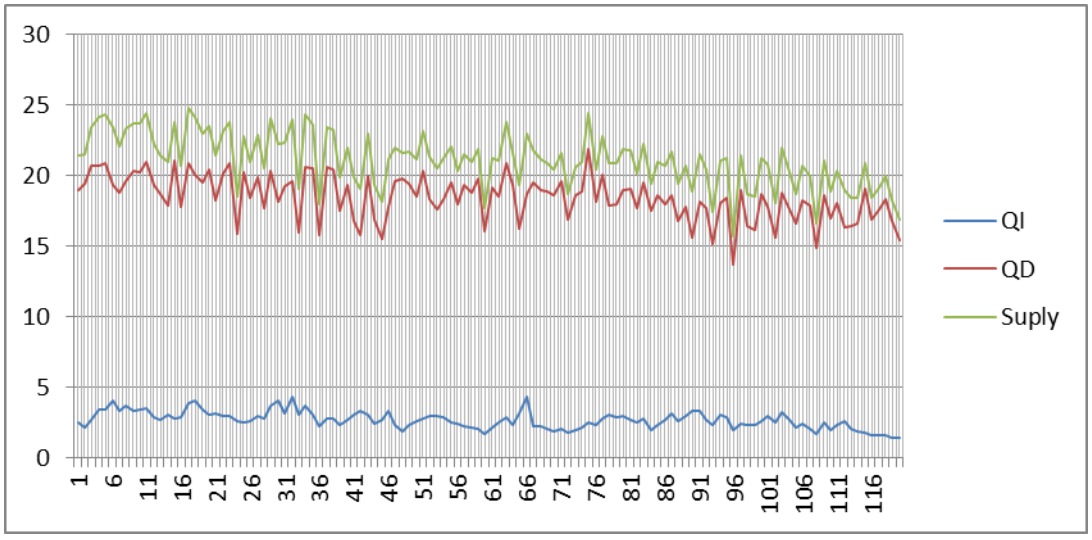

Figure 2. Shows the trends for pork imported from Denmark denoted as Qiton, pork produced and sold in Sweden denoted as Qdton. Theese two added together gives us the supply of Swedish and Danish pork denoted as Supplyton.

If we take a look at Figure 3, showing how the retail prices have changed over time. There are no specific assumptions that can be made except for that the prices have evolved in two different directions. The retail price of Danish imported pork denoted *PIretail/CPI* have become cheaper over time and the domestic Swedish pork denoted *PDretail/CPI* have become more expensive. If we consider the decrease in Danish imports from 2014-04, according to basic economic theory the price for Danish pork should have increased. Any increase in the price cant be observed from Figure 3. This points to the conclusion that something else is responsible for the decline in demand for Danish pork.

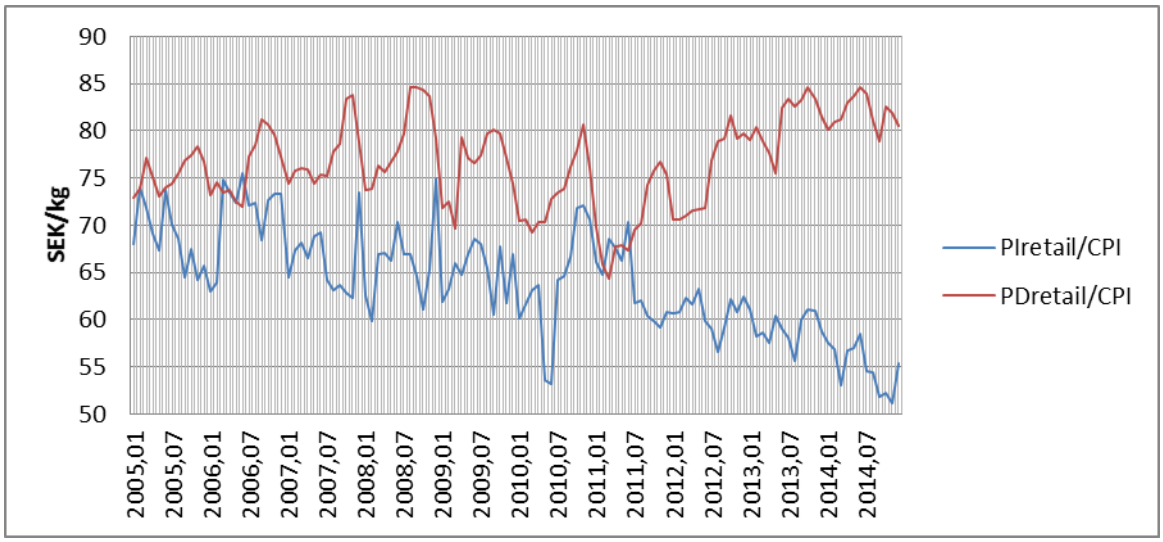

Figure 3. Showing how the retail prices have changed over time.

3.2 Course of Action

Methods to be used will be chosen according the observations made from Figure 1 and Figure 2 and the research question how did MRSA-outbreak in Denmark affect the demand for pork in Sweden?

A Single equation regression of this time series will be used for this purpose. The dependent variable will be the consumption of domestically produced pork,
equal to domestic production minus exports of pork and imported Danish pork in other word the supply of domestic and imported Danish pork. The population of Sweden will divide this so we get the consumed amount of domestic and Danish pork per capita. The regressors or the variables will be retail price for domestic pork and retail price for imported Danish pork and the disposable income per capita. Second a dummy for investigating if structural change has occurred due to the event of the MRSA-outbreak. The dummy will have the value of 0 from the beginning of the time series until 2014-04 where it will take the value of 1 until the end of the time series.

Other dummy variables will be included to account for the seasonality in the time series to do this the dummy will take the value of 1 for each month except one to avoid multicolinearity thus getting eleven dummies with the value of 1 on their respective month and the value of 0 on all the other months. This model will look like:

$$Y=\alpha_0 -\beta_1 x_1 +\beta_2 x_2 +\beta_3 x_3 +\alpha_{SC} D_{SC} +\alpha_1 D_1 \ldots +\alpha_{10} D_{10} +\alpha_{11} D_{11} \qquad (14)$$

The log-log model could then be applied to make the results more easily interpreted. The model would then look like this:

$$lnY=\alpha_0 -\beta_1 ln(x_1) +\beta_2 ln(x_2) +\beta_3 ln(x_3) +\alpha_{SC} D_{SC} +\alpha_1 D_2 \ldots +\alpha_{10} D_{10} +\alpha_{11} D_{11} \qquad (15)$$

The application of the Armington model is also possible; a ratio of the quantity of Swedish pork divided by the imported Danish pork will be the dependent variable. The first variable will be a ratio of the retail prices corresponding to Swedish pork divided by Danish pork. This model will also

include a time-lagged variable for the purpose of examining what the effects of the MRSA-outbreak were in the long-run. This variable will contain of the ratio of q_D over q_F and will have be time-lagged one month. The disposable income per capita will be included in the model for the purpose of examining how income affects the ratio of q_D over q_F. These varibles will be in logarithmic form. All the same dummies as in the previous model will be included in this one. This model will look like:

$$ln\frac{q_D}{q_F} = -\sigma ln\frac{(1-\beta)}{\beta}\left[\frac{p_D}{p_F}\right] + ln\frac{q_D}{q_F}_{(t-1)} + ln\beta_1 x_1 + \alpha_{SC} dm_{SC} + \alpha_1 dm_1 \ldots + \alpha_{10} dm_{10} + \alpha_{11} dm_{11} \quad (16)$$

4 Econometric result

The results from the analysis will now be presented beginning with the log-log model, and then the Armington model.

4.1 Log-Log Model

The first regression was run with the log of total supply per capita of domestic pork and imported Danish pork as the dependent variable, lnS/Capita. The regressors were logs of the retail price of Danish imported pork, retail price of domestic pork and the disposable income per capita. Then the dummy for structural change and the dummies for seasonality were added to the model. These were not in logarithmic form. The regressors were denoted respectively as lnP_F, lnP_D, lnDI/capita, dm_{SC} and dm1 until dm11 for each month.

Table 1. Showing result from regression one and three

Regressors	Dependent variables	lnS/Capita	lnQ_F/capita
intercept		13.7978*** (1.98135)	26.0931*** (4.71770)
lnP_F		0.120904 (0.0987905)	-0.501268** (0.235225)
lnP_D		-0.526643*** (0.124538)	-0.289120 (0.296532)
lnDI/capita		-1.15741*** (0.154700)	-2.47730*** (0.368347)
dm_{SC}		-0.00577887 (0.0268869)	-0.358798*** (0.0640191)
dm1		0.125157*** (0.0300230)	0.106957 (0.0714862)
dm2		0.0976809*** (0.0295691)	0.152204** (0.0704056)
dm3		0.154959*** (0.0290567)	0.248838*** (0.0691855)
dm4		0.354211*** (0.0416876)	0.817414*** (0.0992603)
dm5		0.347878***	0.873551***

		(0.0390219)	(0.0929130)
dm6		0.320559*** (0.0395835)	0.945559*** (0.0942502)
dm7		0.175649*** (0.0283289)	0.351822*** (0.0674526)
dm8		0.157176*** (0.0283871)	0.317486*** (0.0675912)
dm9		0.110993*** (0.0286643)	0.214078*** (0.0682512)
dm10		0.194419*** (0.0285174)	0.311182*** (0.0679013)
dm11		0.199229*** (0.0285449)	0.218524*** (0.0679669)
r^2 adj r^2		0.704406 0.661772	0.681583 0.635657

Standard error in parethesis; observations 120, p < 0.10, * p < 0.05, ** p < 0.01, ***

The result from the first regression is shown in the first column of table one. As see all variables are significant except two. The dummies for seasonality are significant so the seasonality have been accounted for. The retail price for domestic pork has a negative coefficient as anticipated. However the disposable income per capita should have a positive coefficient but it has a negative coefficient. This is most likely due to the cause that the data set only contains Swedish and Danish pork and therefore is missing some of the quantity; with this quantity the coefficient should be positive.

What are next to be acknowledged are the two insignificant variables. They are retail price for imported pork and the dummy for structural change. This result is not very satisfactory for the research questions. Because of this two more regressions were run, one with the quantity of imported Danish pork as the dependent variable and the other one with the quantity of domestic pork as the dependent variable. Both of them had the same variables as the first model.

The one with quantity of domestic pork showed basically the same as model 1 with the same variables significant and insignificant. This can however be suspected. As the quantity of domestic pork haven't directly changed of course very much.

However the second regression with the dependent variable quantity of Danish imported pork, $\ln Q_F$ showed some other results, show in column two in table one.

First we can see that the retail price for imported Danish pork is significant to a five per cent level. But most important we can see that the dummy for structural change is significant at an even higher level. This is proof that the imports of Danish pork have undergone structural change due to the MRSA-outbreaks. The coefficient for the dummy is negative which means that during these months the import of Danish pork was negatively influenced. This confirms what the data set shows us in the method section.

In this regression the retail price for domestic pork has a negative coefficient. It should have a positive coefficient since it's a substitute to imported Danish pork. However it is not significant.

4.2 The Armington model

If we move on to the application of the Armington model to the topic several regressions were run. At first many variables were included in the model but since so many were insignificant they were removed. Finally the model included the logarithmic ratio of quantity of domestic pork over quantity of imported Danish pork $\ln Q_D/Q_F$ as the dependent variable. The other variables are the logarithmic

ratio of domestic retail price over imported retail price lnPratio, the logarithm of disposable income per capita lnDI/capita, the dummy for structural change dm_{SC}, dummies for seasonality for month 4, 5 and 6, and a time lag variable for the dependent variable with the lag of one month $\ln(Q_D/Q_F)_{(t-1)}$. Colum one in table 2 shows the results:

Table 2. Showing the result from the two Armington model regressions.

dependent variables regressors	$\ln Q_D/Q_F$	$\ln Q_D/Q_F$
intercept	-4.90850* (2.81428)	-5.00524* (2.83045)
lnPratio	-0.265473* (0.137246)	-0.272000* (0.138329)
$Ln(Q_D/Q_F)_{(t-1)}$	0.504417*** (0.0665829)	0.499376*** (0.0675648)
lnDI/capita	0.607978** (0.292563)	0.618910** (0.294369)
dm_{SC}	0.222123*** (0.0590354)	-0.0314674 (0.510532)
$dmlnPratio_{SC}$		0.623897 (1.24756)
dm4	-0.248812*** (0.0761273)	-0.248741*** (0.0763859)
dm5	-0.306291*** (0.0725681)	-0.306658*** (0.0728182)
dm6	-0.361789*** (0.0751319)	-0.361732*** (0.0753871)
r^2 adj r^2	0.670422 0.649638	0.671170 0.647255

Standard error in parethesis; observations 119, $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, ***

From this regression we can observe that all the variables are significant to at least a 10% level. What is the most interesting with this regression is that it shows a high significance for the dummy for structural change, dmSC. Yet another proof that the demand for pork has undergone structural change. Another interesting observation is the lagged variable, $\ln(Q_D/Q_I)_{(t-1)}$. This means that in the long-run the effect of the dummy for structural change or rather what it represents will increase with the coefficient of the dummy divided by the coefficient of the lagged variable, 0.226049 / 0.549110 = 0.411664. This can be interpreted as an upward shift in the intercept from where the dummy starts to be active. Meaning that the ratio for domestic pork over imported Danish pork has increased in favor of the domestic pork.

The variable for price ratio, lnPratio has a negative coefficient to the value of -0.2720. This variable shows the elasticity of substitution between the demanded quantities and the prices during the time period. This means that changes in the price for pork has made he consumer consume 27.2% more Danish pork today than in the beginning of the time period. Predicting the long-run change in consumer behavior for pork in Sweden might be difficult because it is difficult to know how long the effects of the MRSA-outbreak will last.

The variable for disposable income, lnDI/capita show a positive coefficient. This suggests that a higher income would make consumers consume more domestic pork. The high R-squared values give

the model a high credibility of describing the data set, thus the model likely describes the reality quite well.

In an attempt to refine the model and give a more exact picture of how the elasticity of substitution of quantities for prices appears from the start of the structural change some modifications were made. The logarithmic price ratio variable was multiplied with the dummy for structural change so it during the regression only runs while the structural change has occurred. The result is showed in column two in table 2. The combined dummy denoted, $dmlnPratio_{SC}$ shows that the variable is not significant. This means that the change in the dependent variable during the last three quarters in 2014 when the dummy is active cannot be derived from the changes in the price during the same time period. In other words the change in demand is not due to changes in the retail prices for pork in the time period of the dummy. This further reinforces the likelihood that structural change has occurred because of the MRSA-outbreak.

5 Concusion and discussion

What are the conclusions we can draw form this research? We can start with revisiting the research question “how did the MRSA-outbreak in Danish pig stables affect the consumption of pork in Sweden?”

The two models that were applied to research this has clearly shown that there has been a structural change in the demand for pork due to the MRSA-outbreak. They tell us that the demand for Danish pork has decreased during the last three quarters of 2014. What was most important in the log-log model, the model with $\ln Q_F$ as the dependent variable was that the coefficient for the structural change dummy was both negative and significant. This implies that the imports of Danish pork were negatively affected in the time period of 2014-04 until 2014-12. In the Armington model there is more proof for structural change but it is also interesting in the way that it describes how the pork market in Sweden has changed over the last ten years quite well.

The second question was “who are the benefiters from the outbreaks and who were losers and also if we still can see effects from the MRSA-bacteria outbreaks in 2014 in the market?” Well the losers clearly are the Danish pig farmers. The benefiters however aren’t as clear. Since the demand for Swedish pork hasn’t increased which both the log-log model and the overlook of the data set shows they haven’t benefitted in that way. Tough if we see to the results of the Armington model, they show that the domestic over imported quantity ratio has increased in favor of domestic pork, thus giving the Swedish pig farmers a larger market share. In this sense one could argue that Swedish pig farmers have benefitted from the MRSA-outbreak.

These results are consistent with the results in the study by Tonsor et al (2011) that an increased awareness in how meat is produced decreases the demand for it. The results are also similar to the study by Peterson and Chen (2005), that food scares is consistent with a decline in the demand. However the differ from Peterson and Chen (2005) in the way that the demand for domestic pork did not decline. This is likely due to the fact that Swedish pigs are not affected with the MRSA-bacteria. The results in the study by Pigott and Marsh showed that changes in demand were more likely due to changes in price. This study opposes that and argues that in this case the changes in deman were because of the food scare that the MRSA-outbreaks caused.

Regardless of the results one has to be careful when interpreting them due to several different aspects. For example the assumption about how much production and import prices will grow along the supply chain when becoming retail prices. These might seem to be taken out of thin air. Anyway these assumptions are made to mimic the retail prices of today.

The assumption of average amount of people in the household during 2014 is expected to have very little impact on the difference in disposable income per capita considering that the data shows that the average amount of people in the household has been 2 ±0,05 during the last ten years

Another reason that might complicate the interpretation of the results are the fact that the data set only contains Danish imported quantities of pork and not the total imports this might also be a reason that the log-log model didn’t show more satisfying results. One could argue that because the quantity of imported pork is such a small part of the sample, roughly one eight of the total supply of pork. A change in the Danish imports would therefore be even smaller. If the imports were to be halved this would then only correspond to roughly one sixteenth of the sample and this might not be detected as a change in the demand curve. However this is only a speculation.

Since MRSA changed the structure for the pork market in Sweden whom is not the only importer of Danish pork. One could suspect that the MRSA-outbreak have had similar effects in other countries

and markets. This could be a topic for further research. Other research that could be done in the subject is for example the long-run effects of the MRSA-outbreak. If more data regarding the imports and the production of pork during 2015 and further on is obtained this could be done in a similar manner as in this study. The research can also expand in the sense that one incorporates a substitute for pork into the model to research the cross elasticities and if demand shifts from one good to the other.

New insights gained from this study are a better understanding of the Swedish pork markets sensitivity to food scares such as the MRSA-outbreak. Furthermore the study shows how the Swedish pork market has changed during the last ten years in favor of imported pork as a result of changes in the prices of domestic and imported pork. These are the concluding remarks of this thesis.

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