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Determinants of regional comparative advantages in food industries

By

Sara Johansson^a and Therese Norman^b

Abstract

International markets for food products have shown a strong growth in recent years. Trade flows between countries are increasing and can be seen as a reflection of a higher degree of competition in both domestic and international markets. At the same time, consumers show a growing interest in product attributes associated with the geographical origin of the product and/or specific production methods.

This paper studies the region specialization in food industries and uses a shift share analysis to identify regions with comparative advantages in food production in Sweden. The Swedish food sector is of significant size in the domestic economy, and is the fourth largest industry in the Swedish manufacturing sector. The food sector hosts both small and large firms, and is represented in all (geographical) parts of the country. As in many European countries, the food sector is important with respect to employment in rural areas and therefore an obvious target for rural policies.

Recent studies of food industries indicate that differences in regional characteristics, such as concentration of firms in the industry (clusters) and concentration of food exporters partly explain the export behavior of firms in the Swedish food industry¹ and food processing firms in France². These findings indicate that location specific factors impact on firms' competitiveness in international markets. This paper explores this issue further in an empirical analysis of regional comparative advantages in food processing. The purpose of this study is to analyze what type of regional characteristics that stimulate regional specialization in food industries. Of particular interest is the importance of unique regional food specialties, small-scale manufacturing, size of the local market and accessibility to foreign customers in shaping regional comparative advantages in food manufacturing.

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¹ Johansson, S. (2008). Livsmedelsföretagen och exportmarknaden – Vilka faktorer stimulerar företagens exportdeltagande? Jordbruksverket Rapport 2008: 17

² Chevazzus-Lozza, E. And D. Galliano (2003) "Local Spillover, Firm Organization and Export behavior: Evidences from the French Food Industry", *Regional Studies*, Vol. 37, pp. 147-158

1 Introduction

The food manufacturing industry is the fourth largest manufacturing industry in Sweden. The food sector hosts both small and large firms and is represented in all geographic areas of the country. This sector provides employment in rural areas and is an obvious target for rural policies. Different regional characteristics, referred to as regional comparative advantages, are of special importance for the growth of the food manufacturing industry.

Even though the number of food manufacturing workers has decreased in Sweden from a national perspective since the beginning of the 1990's, some regions have experienced a substantial increase of employees within the food industry. In order to determine whether these regions have grown due to regional characteristics such as comparative advantages or due to a favorable industry mix or the national economic climate, a shift share analysis has been applied. The regional component of a shift share analysis represents a measure of comparative advantage. Specifically, the regional component for the food industry evaluates how much of the increase in the food manufacturing industry that can be attributed to favorable regional characteristics.

Furthering the analysis, regional economic and location theory explain the underlying factors influencing these comparative advantages. Comparative advantage is a fundamental concept of a region's competitiveness relative to another region within a specific industry. One source of a comparative advantage is concentration of firms (clustering) within the same region, which leads to agglomeration effects. The "New Economic Geography" theory focuses on agglomeration effects and its positive externalities, which arise from internal economies of scale at the level of the firm and external economies of scale (Cohen et al, 2004). This theory was partly developed by Krugman (1980), when he showed that transport costs generate a "home market effect", which implies that a country with a relatively large home market for a good is often a net exporter of that good. With these concepts mind, there is a tendency for firms to locate near its home market even though there is a demand for the good in other markets. Both internal and external economies of scale initiate and feed the specialization and concentration of firms.

In addition to clustering of manufacturing firms, agglomeration effects emerge through limited transportation costs through high accessibility to input material and accessibility to

markets. Small-scale manufacturing could also be a potential characteristic stimulating regional specialization in food industries and food export. Another beneficial feature of regions for food producing firms might be the existence of a large pool of manufacturing workers.

This paper will focus on regional comparative advantages in food industries from 1992 to 2007 by analyzing five year cross sectional data. There are two steps involved in this analysis. The first step is to use the shift share analysis to detect regional comparative advantages. Once the pattern of regions exhibiting comparative advantages for food production is established, the objective is to analyze the cause of this phenomenon. Consequently, the second step is to perform a regression analysis of factors influencing the regional comparative advantages.

The analysis has been performed over three time periods since there is reason to believe that external factors might cause the regional comparative advantages and the sources of these advantages to vary over time. The market demand and trade regulations might change over time for example. One subject of interest is whether or not the determinants of comparative advantages have changed over time and therefore changed the structure of the food industry in Sweden. The question researched by this paper is whether regional comparative advantages in the food manufacturing industry are driven by different agglomeration forces such as external economies of scale and if these forces remain constant over time.

The second section of the paper begins with an introduction to economic concepts related to comparative advantages, monopolistic competition and trade. The discussion then turns to the new economic theory and its agglomeration effects. The second chapter is concluded by a few arguments of specific determinants of food manufacturing industry growth. The third chapter explains the shift share analysis, the method and the model of the regression analysis. In the fourth chapter, the regression outcomes are presented coupled with an analysis of the results. The fifth and last section concludes the paper with a summary of the findings.

2 Theoretical Background

2.1 Comparative advantages, monopolistic competition and trade

The theory of comparative advantages is a fundamental economic concept that contributes to the explanation of specialization and trade. It relies on cross-country differences in pre-trade relative prices, which arise due to differences in relative factor prices (Heckscher-Ohlin) or because of differences in production technology (Ricardo). Trade patterns with location specific differences in production costs are explained through these two theoretical standpoints. In the Heckscher-Ohlin factors proportion theory, differences in relative factor endowments are the sources of cost advantages, whereas in the Ricardian theory, differences in factor productivity drives the cost advantages. Both theories propose that a country should specialize in the production of the good where it has a comparative advantage.

The product life cycle models of international trade developed from Posner's idea. One version of the Posner (1961) introduced the product life cycle theory with dynamic rather than static comparative advantages. The spatial version of the product life cycle model further emphasizes the importance of proximity to large markets for cost advantages and competitiveness. Spatial product cycle theories therefore build on location theories and the pioneering work of von Thünen (1826), Weber (1909), Hotelling (1929). A spatial framework for analyzing regional comparative advantages in a dynamic context was conceptualized by Andersson and Johansson (1984; 1998).

Product life cycle theories provided some evidence of why similar countries trade similar goods, but they did not explain intra-industry trade. Krugman (1979a; 1980), Dixit and Norman (1980), and Lancaster (1980) approached international trade by relaxing the assumption of constant returns to scale. The concept of monopolistic competition allowed Krugman (1994) to formalize a model of trade exhibiting increasing returns to scale at the level of the firm. Monopolistic competition relates to the idea put forward by Chamberlin (1933) that many markets consists of products that are physically similar but economically differentiated since they appeal to different customers. This leads to each firm having its own perceived demand curve and market power. Competitive elements are however included due to a large number of firms and the possibility of entry and exit. These conditions are sufficient for a partial market equilibrium where firms make zero profits.

Dixit and Stiglitz (1977) refined Chamberlin's model of monopolistic competition, which became known as the "New Trade Theory". In addition to monopolistic competition, scale economies and endogenous product variety, the Dixit and Stiglitz model also provides an equilibrium number of product varieties that is socially optimal given product-specific scale economies and utility arising from diversity. Krugman (1979; 1980; 1981) applied the Dixit and Stiglitz model when he formalized the model of trade with increasing returns and product differentiation. The consequent of Krugman's model was the idea that trade can be a result of a simple extension of the market and the allowance for full exploitation of economies of scale at the level of the firm, rather than cross country differences in technology or factor proportions.

The theory discussed above was developed into Krugman's core-periphery model. This model shows how the interactions among increasing returns at the level of the firm, transport costs, and factor mobility can influence spatial economic structures (Fujita et al, 2000). The core-periphery model later became known as the "new economic geography".

2.2 New economic geography

Spatial economics is a field that recently has received increasing attention. Although, the location of firms and concentration of economic activity appear to be a result of historical accident, the development of these spatial patterns has several theoretical explanations. Agglomeration economies, where the spatial concentration of firms provides economic advantages for more firms to locate in close proximity exist in all countries (Fujita et al, 2000). In Sweden we observe clustering of firms such as the vehicles industry in the Gothenburg region for example.

As illustrated by Johansson, Karlsson and Stough (2002) there are two frameworks explaining economic specialization of regions. The traditional framework presumes that comparative advantages of regions depend upon differences in the supply of lasting resources. This theory suggests that firms and industries might be trapped to certain geographical locations. As a complementary theory, the new economic geography theory assumes that the dynamic interaction between geographic market potentials and rational firms creates comparative advantages of regions. The comparative advantages within this framework originate from localized increasing returns to scale. Regional specialization based on clusters and

geographical competitive advantages drives economic development in a country. The notion that regional growth comes from internal conditions indicates that it can be influenced by policy and other processes.

The new economic geography relies on the Dixit-Stiglitz model of monopolistic competition. As mentioned in the previous section, the model entails increasing returns at the level of the firm, which assists in the explanation of the nature of competition. If such internal increasing returns were not present, firms would establish a separate facility to serve each market rather than concentrate production where the market is largest (Fujita et al, 2000). Moreover, in economic geography the role of cumulative processes is emphasized. In contrast to a static model, the new economic geography contains dynamic features where spatial concentration reinforces itself (Fujita et al, 2000).

Krugman (1980; 1981), Cohen and Morrison Paul (2004) and Fujita et al (2000) describe how the phenomena of geographical concentration of firms, regional specialization and the importance of the home market are results of the existence of increasing returns, which is also one explanation for trade between regions. Increasing returns, or scale advantages, exist when the relationship between the scale of production and the average cost per produced unit is negative. This negative relationship occurs when one of the factors of production has fixed costs, such as set-up costs. According to Krugman (1981), the existence of internal economies of scale is essential for agglomeration effects to be advantageous.

In addition to internal economies of scale, external economies of scale are also a fundamental concept influencing firms to concentrate spatially. With external economies of scale, the unit cost for each firm in an industry will decrease as more firms are added to the region. Alfred Marshall (1920) was the pioneer with this concept and argued that there are three explanations for external economies of scale and co-location. These are intra-regional spillovers of information and knowledge; the location of specialized supporting firms; and the emergence of specialized labor markets (Krugman, 1991). These three causes of external economies of scale will both develop and strengthen specialization and growth in a region that has already been initiated by internal economies of scale.

The model of the new economic geography also includes geographical interaction costs, which involves both transportation costs and transaction costs (Krugman, 1991). Firms

producing goods with high geographical interaction cost will not sell its products beyond the borders of the region. A firm producing products with low geographical interaction costs can export most of its output, but may have input supplier accessibility requirements. If these suppliers have internal economies of scale, they would benefit from locating in the same region as the exporting firms with large demand. As a result, even firms selling local commodities, would be attracted to larger urban regions by the large variation of inputs created by suppliers in these regions (Johansson et al, 2002).

The presence of transportation costs and increasing returns at the level of the firm brings advantages associated with concentrating production in a region with a large home market and cause firms to locate there even if demand exists in another region. Krugman (1980) emphasizes the home market effect as one of the implications of the new economic geography, which implies that firms will export those products for which they have the largest home market demand in relative terms. Production will be concentrated close to its home market, even though there might be demand for the product elsewhere. Consequently, rather than spreading out production to avoid competition and to meet a geographically spread demand, firms will concentrate production within particular regions.

According to Krugman (1991), only in a world with internal economies of scale can geographical interaction costs and market forces give rise to cumulative processes and agglomeration advantages. Accordingly, internal economies of scale and cumulative processes make it possible to show that regions that have the same production resources may specialize in different ways. Furthermore, preceding theory suggests that regional specialization is an historical accident to some extent. Once a pattern of specialization is established, cumulative gains from interregional trade add force to this pattern. If factors are mobile, cumulative effects can increase market potential in a region, and thereby create a market place for an increasing number of industries and firms with internal economies of scale. This market place is the regional firms' home market. Export to other regions is generated when such firms get customers outside the home region.

A distinction has been made by Ohlin (1933) between agglomeration economies due to urbanization and agglomeration economies due to localization of production activities. Urbanization economies are the result of spatial concentration of overall economic activity whereas localization economies results when there is concentration of one particular industry

in a specific geographical area (Johansson, 2010). In accordance, urbanization economies are external economies of scale related to the size and diversity of the market. Localization economies are external economies of scale related to the size and structure of the local industry. Duranton and Puga (2000) mentions that the strength of these local externalities varies; they might be stronger in some sectors and weaker in others.

Diseconomies of agglomeration may also occur, as pointed out by Arthur (1990). In this instance, the net benefits decreases with an increasing number of firms. Diseconomies of scale relates to congestion effects, such as more expensive land and increased competition.

2.3 Determinants of growth of food manufacturing industries

There is naturally relevance in discussing whether all manufacturing industries behave identically or not. As already mentioned, economies of scale can be external, internal or both. The causes of external economies of scale as put forward by Marshall (1920) might be highly applicable to the food manufacturing industry. The concentration of many similar firms in one locational offers a pooled market for workers with industry-specific skills, which ensures a lower probability of labor-shortage and unemployment (Krugman, 1991). Therefore, a large share of manufacturing workers could be important for the localization of food manufacturing firms. In addition, clustering of firms can support the production of non-tradable, specialized inputs (Krugman, 1991). In the case of food manufacturing industries, the producers of inputs are not mobile and their location is exogenously determined. Furthermore the inputs are perishable and often expensive to transport. These facts imply that food manufacturers should locate close to its inputs.

Since these inputs are farmers and fish producing firms, they will usually not be in urban regions. However, the demand for food manufactured products will increase as a region becomes more urbanized. In contrast to agricultural producers, manufacturers are mobile and often characterized by increasing returns to scale (Krugman, 1991). According to Krugman, the manufacturer should choose to locate where there is a large market. However, two different forces pull food manufacturers in opposite directions between proximity to its input and its output markets. The notion that input suppliers to food manufacturers might be trapped to certain geographical locations counteracts the theory of localization due to agglomeration

economies. One of the forces driving the localization decisions for these firms would be whether raw materials or output products are more expensive to transport.

Another special feature related to food manufacturing is the recently increasing importance of small-scale production. The Swedish population is demanding higher quality products associated with small-scale producers. As mentioned, this is however a fairly recent development in the food industry.

The literature on location of manufacturing industries is extensive. Goetz (1997) presents a few ideas related to the behavior of food manufacturers. He mentions that food manufacturing does not differ from other industries in the sense that all industries seek to maximize profits. There are, however, a few reasons to believe that food manufacturing industries should differ from non-food manufacturing industries. Goetz proposes that various types of inputs to food processing are costly to transport and therefore food manufacturing firms might locate close to its suppliers of raw materials. Equally some processed food products are perishable and the firms might require close proximity to its market. In contrast, according to Capps (1988), another type of “footloose” food processing industries exist, for which neither the supply of input materials, nor the market for output products dominate location decisions.

Goetz (1997) mentions a few different categories of variables that determine establishment or growth of manufacturing firms. These variables are; access to output markets, labor force composition and quality, transportation infrastructure, regional policy, availability of raw materials and intra- and inter-industry specific agglomeration economies. Similarly, Shaffer (1979) describes access to markets, labor force, economic activity, and policy variables as determinants of regional comparative advantages. Some theorists highlight the importance of proximity to agricultural output due to high transportation costs of this product (Newman, 1983). Others emphasize the output market or an established industry for agglomeration advantages as more important factors for food manufacturing growth (Krugman, 1991; Barkema, Drabenstott & Stanley, 1990). Moreover, economists consider low labor costs and limited union activity as a beneficial characteristic enhancing growth of manufacturing firms (Melton & Huffman, 1995). Goetz (1997) found in his results that larger employment shares in the low skill, lower-wage workers attract manufacturing firms to take advantage of high turnover rates per employee in American states.

Furthermore Goetz (1997) finds that agglomeration economies exist for industries at the state level as measured by existing establishments per capita. However, agglomeration diseconomies were detected at the county level for all foods except beverages. Further, Shaffer (1979) asserts that distance to markets has a negative and significant effect on determining the regional share. In his conclusion, Shaffer (1979) mentions that access to markets is the major determinant of the regional share and competitive advantages.

3 Method and the Model

3.1 Shift share analysis

Local industries can be growing or declining and some industries fare better in particular regions than others. Industry growth in a region can originate from local effects or national trends. For this reason, industries with comparative local advantages should be considered when targeting public policy. In Sweden there are approximately 290 different municipalities (depending on the year) with different composition of industries, all with different local labor growth. Since regional labor market development can be caused by different factors, it is not sufficient to only know that employment changes have occurred. Local growth factors need to be separated from national growth factors or the local economic structure in order to identify industries with regional comparative advantages.

In order to pinpoint the sources of growth of a local industry a descriptive method known as shift-share analysis is applied. This descriptive method measures the movement (shift) of the local region into faster or slower growth sectors and the region's smaller or larger share of the growth occurring within a specific economic sector (Shaffer, 1979). In a sense, Shaffer argues that the shift share analysis assists in discovering the residual component of employment change after adjusting for national economic conditions and local economic structure. The analysis decomposes employment changes within a region over a time period into three contributing factors³:

1. *National share* measures how much of the local employment change is attributable to growth of the national economy.

³ The explanations and definitions of the shift-share analysis are from Shields and Unknown Author.

2. *Industry mix* identifies fast growing or slow growing industries in a region based on the national average growth rate. This component measures if the structure of a region is such that it is weighted toward industries that grow faster than the national average growth.

3. *Regional shift* is the component of greatest interest for this paper. It measures a local area's growth rate of an industry, with the growth rate for that industry at a national level. It identifies leading and lagging industries. The regional shift helps identify whether local businesses are more or less competitive than the national average. If this component is positive, it means that the relative competitive position of a region has created a greater share of employment growth than did the nation on average. Furthermore, the competitive advantage of individual industries in the region can be determined by analyzing the regional shift.

The shift share formula: $SS = NS + IM + RS$

where NS (National Share): $local_i^{t-1} * \frac{(NE^t - NE^{t-1})}{NE^{t-1}}$

where IM (Industry Mix): $local_i^{t-1} * \frac{(NE_i^t - NE_i^{t-1})}{NE_i^{t-1}} - NS$

where RS (Regional Share): $local_i^{t-1} * \left[\frac{local_i^t}{local_i^{t-1}} - \frac{(NE_i^t - NE_i^{t-1})}{NE_i^{t-1}} \right]$

The NS component is calculated as the local industry employment in the base year ($local_i^{t-1}$) times the national average growth rate of total employment ($\frac{(NE^t - NE^{t-1})}{NE^{t-1}}$).

The IM component is calculated as the local industry employment in the base year ($local_i^{t-1}$) times [the national *industry* growth rate ($\frac{(NE_i^t - NE_i^{t-1})}{NE_i^{t-1}}$) minus the national *average* growth rate ($\frac{(NE^t - NE^{t-1})}{NE^{t-1}}$)]

The RS component is calculated as the local industry employment in the base year ($local_i^{t-1}$) times [*local* industry growth rate ($\frac{local_i^t}{local_i^{t-1}}$) minus *national* industry growth rate ($\frac{(NE_i^t - NE_i^{t-1})}{NE_i^{t-1}}$)]

The regional component gives a measurement of comparative advantages of a municipality or a specific industry in that municipality. The interpretation of the results is no straight forward since regions can essentially be declining in an industry in absolute figures but obtain a positive regional shift component for this industry. The reason for this is that, considering, the industry mix and the national economy growth, the region “should have” subtracted even more jobs than it actually did. Therefore, the regional shift for this industry becomes positive. *Ceteris paribus*, the region in question would have increased its number of workers within the industry, but national trends resulted in an actual decrease of workers in the industry.

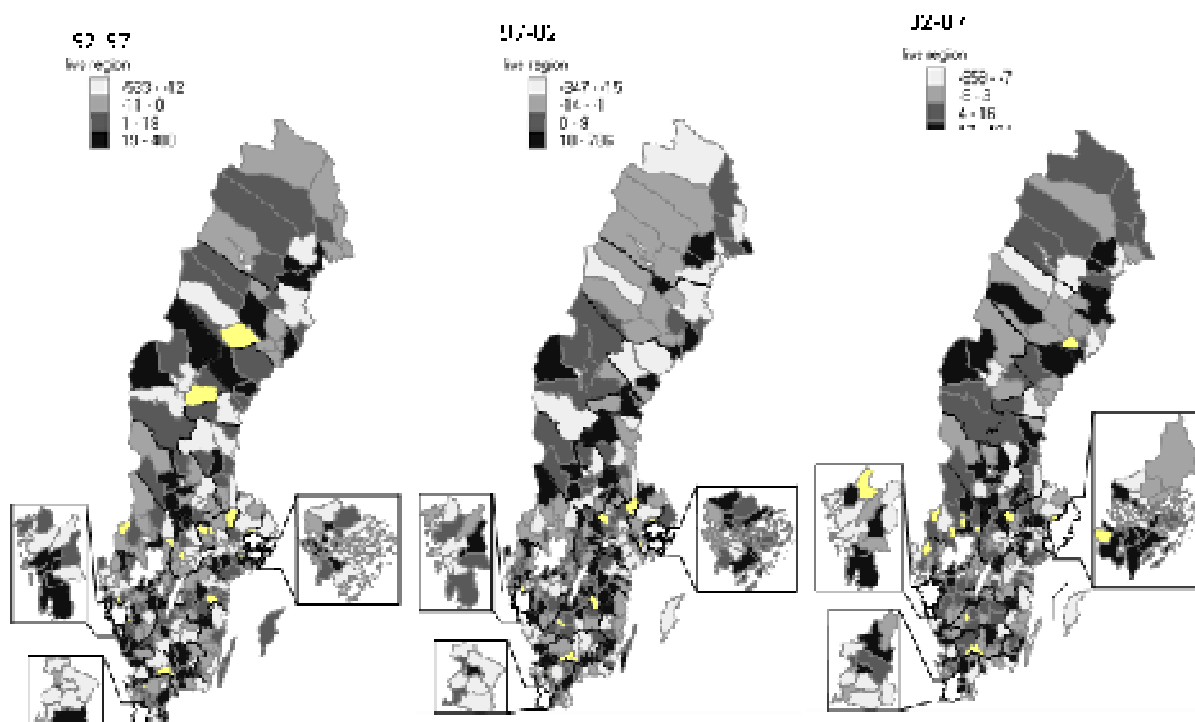
The consequence of this measurement strategy results in some difficulties when it comes to determining the causes of comparative advantages. The data has already been “rinsed” from these trends and the variation becomes difficult to predict by the explanatory variables. For example, municipalities where the food manufacturing industry is the only growing industry will receive very high regional shift values, whereas municipalities with a food manufacturing industry growing at the same rate, but also with other growing industries will receive a lower regional shift value than the former. However, the regional shift should be interpreted as an indication of whether local industries are more or less competitive than the national average. In a sense, the component reveals if the municipality itself created a greater share of employment growth than did the nation on average (Shields).

3.1.1 Results from shift share analysis

The maps below display levels of comparative advantage in food industries of the municipalities in Sweden. Darker areas signify a higher comparative advantage.⁴

⁴See table 7.1 in appendix demonstrating the 20 municipalities with the largest regional component for the food industry between 1992 and 2007.

Figure 3.1 Municipalities with lowto-high regional shift in food manufacturing.



The maps above illustrate where the food industry has demonstrated a stronger or weaker growth as measured by the regional shift of manufacturing jobs. The results show a quite random, chessboard-like pattern. It is difficult to witness any concentration of nearby municipalities where the regional shift of the food manufacturing industry has shown a particularly strong growth pattern. Furthermore, studying the maps closely reveals that the pattern changes over the three time periods, with the middle period (1997-2002) displaying the most divergent pattern.

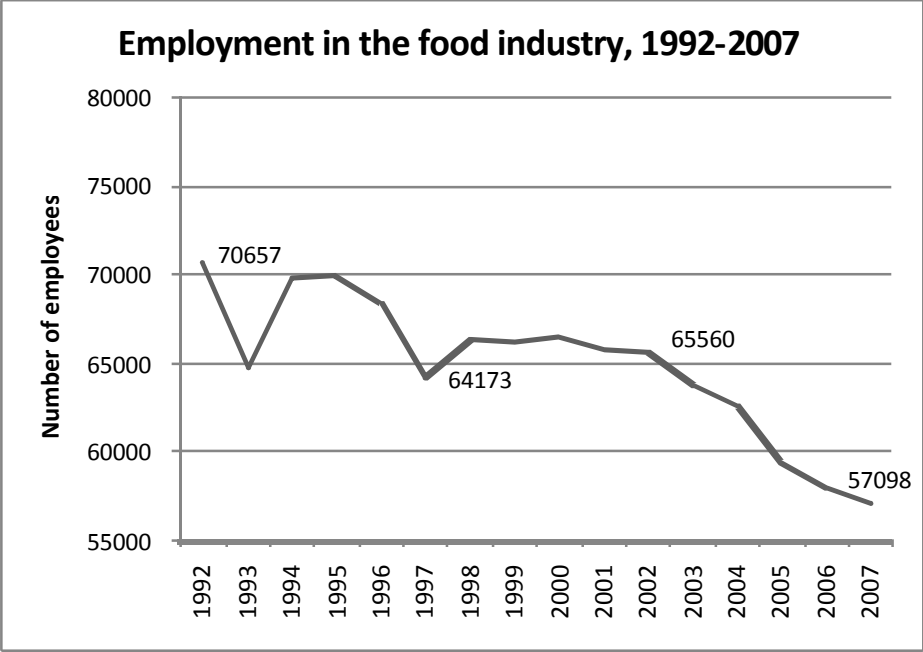
The shift-share analysis is a descriptive method rather than a diagnostic one. Although regional comparative advantages can be determined through this tool, it does not reveal the causes of these advantages. This paper will continue by attempting an analysis of the determinants of regions with comparative advantages in the food processing industry.

3.2 Descriptive statistics and data

Below is a diagram showing the development of employment in the food industry from 1992 to 2007, the period of analysis of this paper. As can be seen, the decrease of employment in the food industry is rather substantial for the period between 1992 and 1997 and for the period

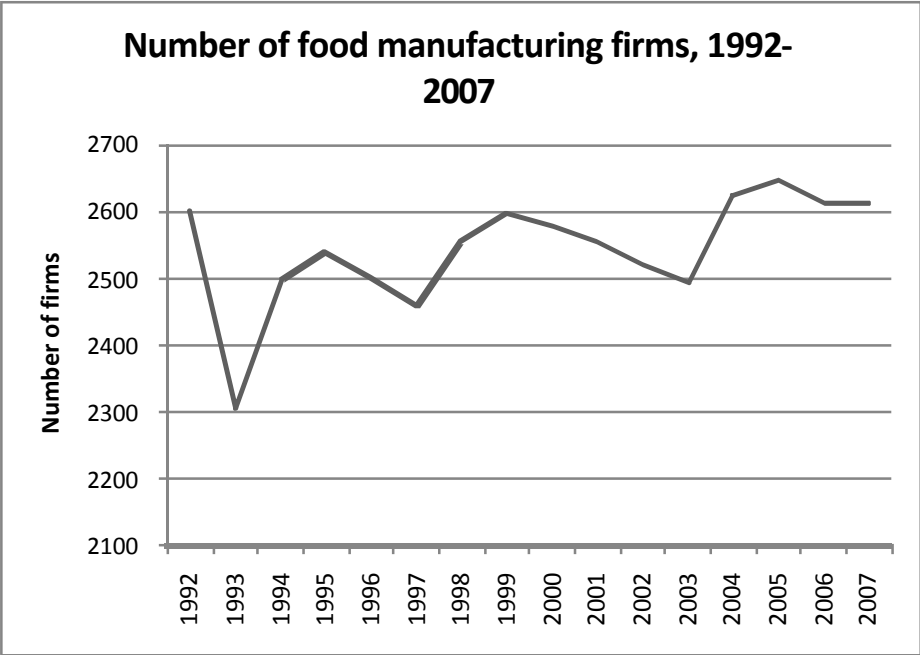
between 2002 and 2007. However, for the period between 1997 and 2002, the number of food manufacture employees is slightly increasing. As will be discovered, the regression results will differ for this period in contrast to the other two periods studied.

Figure 3.2 Development of number of employees in the food manufacturing industry, 1992-2007



The steady decrease of employment in the food industry indicates a restructuring of food manufacturers. The decrease of food manufacturer jobs in the large cities of Stockholm, Gothenburg and Malmö are between 24 and 42 percent. On the other hand the employment in the food industry has been growing substantially in many of the smaller municipalities.

Figure 3.3 Development of number of firms in the food manufacturing industry, 1992-2007



While employment in the food manufacturing industry has contracted during the time period in question, the number of firms in this industry has increased. The reason for this could be that the development of the past couple of years has been characterized by an increase in small-scale food producers and that food manufacturing has become more capital intensive. The pattern suggests that internal economies of scale are becoming less important, while external economies of scale is becoming more important. Due to unavailability of data, there is no knowledge of the development of the output of the food manufacturing industry during these years.

In order to determine the level of employment-concentration and firm-concentration of the food manufacturing industry, a Herfindahl-Hirschman Index (HHI) has been constructed. This is a well-known index generally used to calculate the degree of competition in an industry. In this case, the index demonstrates whether the food manufacturing industry is equally spread out throughout the nation or concentrated to a few municipalities. The HHI index is defined as the sum of the municipalities' share of employment (or firms) in the food industry squared. The equation follows below:

$$HHI = \sum_{i=1}^n s_i^2$$

where s_i is the share of employees (or firms). A HHI index of 1 indicates that all employees (or firms) are concentrated to one municipality. The lower the HHI value, the more equally spread out is the employment (or firms) of the food industry.

The result of the calculations yields a HHI index around 0.02 estimated for employment for all years and the index estimated for number of firms is about 0.01 for all years. Both of these indexes are very low, indicating that the food manufacturing industry is spread out across the nation to a large degree and the pattern has not changed noticeably. The outcome suggests that agglomeration economies do not drive the food manufacturing industry in Sweden to a large extent. However, more formal analysis needs to be applied in order to determine the driving forces of the localization and growth of the food manufacturing industry.

The first step taken in order to establish the determinants of the regional localization of the food industry is to investigate whether the pattern of its growth is converging or diverging. If the food industry is growing at a faster pace in regions where it is originally small and at a relatively slower pace where it is large, the regions are converging. When the opposite occurs, the regions have a diverging pattern of growth in the food industry. A simple regression was performed for the three time periods in the study with growth of employees in the food industry as the dependent variable and the number of employees in the base year as the explanatory variable. All three regressions provide evidence for a regional convergence in food industries, since the coefficient of the amount of workers in the base year was significant and negative.

This result implies that the food industry is growing slower where it was originally large in comparison to where was originally small. The next step is to determine which variables cause the growth of the food industry. Even though a region has a relatively small food industry in comparison to other regions, the relative concentration of the food industry can be quite large in this region, when controlling for other factors such as the original size of the food industry.

In order to capture agglomeration effects, a *location quotient* of the concentration of firms in food manufacturing (C_F) is calculated as follows:

$$CF = \frac{\text{share of the country's food manufacturing firms located in municipality } j}{\text{share of the country's total firms located in municipality } j}$$

This location quotient therefore measures the concentration of food manufacturing firms regardless of the size of the region.

Obviously large regions have a larger potential to add more or subtract more jobs in food manufacturing than smaller regions. Therefore the original *size of the food manufacturing sector* must be controlled for when assessing the impact of the concentration of food manufacturers on the regions comparative advantages in creating food manufacture jobs.

The number of *input suppliers* also captures agglomeration economies in the municipality and the importance of a close proximity to a firms' raw material. Moreover, the *share of manufacturing workers* relative to all workers in a municipality is included to capture the size of the pool of manufacturing workers. Municipalities with a high share of workers within manufacturing (low-skilled) have high turnover rates per worker.

In addition, the *total employment* in the municipality is included. Shaffer (1979) includes employment data as a determinant of the regional share of Wisconsin counties, since among other reasons; it is a commonly accepted measure for economic activity. *Share of small scale firms* is included in order to capture the extent of entrepreneurship and small scale production in the municipality.

Accessibility to the population measures the size of the potential market. A higher accessibility to the population implies that a food manufacturing firm faces a larger potential market. This variable also captures agglomeration economies that are not specific to food manufacturing industries since larger populations are associated with services such as transport (Goetz, 1997).

Table 3.1 Definition of variables

Variable name	Description	Definition	Expected impact
RSF_j	<i>Regional shift in food manufacturing in municipality j</i>	<i>Dependent variable</i>	
$EMPF_j$	Number of employees in food industry in base year in municipality j	Captures size of industry	Positive or negative
CF_j	Location quotient of food industry concentration in municipality j in base year	Captures the importance of the industry in the municipality relative to all municipalities	Positive
$MANU_j$	Share of employees in manufacturing industry relative to all employees in municipality j in base year	Measures the impact of a large pool of workers within manufacturing in the municipality relative to all workers	Positive
$INPUT_j$	Number of input suppliers in base year in municipality j	Captures the importance of farming and fishing suppliers in the municipality	Positive
$EMPTOT_j$	Total number of employees in municipality j	Captures the size of the municipality	Positive or negative
$SMALLF_j$	Share of small-scale firms relative to total firms in municipality j in base year	Captures the importance of a high degree of entrepreneurship in a municipality.	Positive
POP_{ACCESS}	Accessibility to population	Captures the size of the potential market.	Positive

The data is firm level data from SCB (Statistics Sweden) called “AST Statistics” and covers the period between 1992 and 2007. One limitation of the data is that it does not include firms with zero employees and therefore significantly alters the variable measuring the number of small-scale firms.

3.3 The regression model

Estimations with ordinary least squares require that the residuals have certain properties. The errors need to be uncorrelated and homoscedastic, implying equal variances. These assumptions do not hold for the regression analysis in this case. In particular, the estimators contain some degree of heteroscedasticity. For this reason, a generalized least squares

regression has been applied with a robust covariance matrix to correct for heteroscedasticity (Gujarati, 2009). The method to adjust the variance-covariance matrix of a fit from least squares is known as the Huber-White method (STATA). The method involves correcting the covariance matrix for model misspecification by using the ordinary estimates of the regression coefficients and other parameters of the model. Consequently, the estimates yielded by the GLS will be the best linear unbiased estimators.

In order to explore the determinants of regional comparative advantages in the food industry, the following regression equation has been applied:

$$RSF_j = \beta_0 + \beta_1 EMPF_j + \beta_2 CF_j + \beta_3 MANU_j + \beta_4 INPUT_j + \beta_5 EMPTOT_j + \beta_6 SMALLF_j + \beta_7 POP_{ACCESSj} + \varepsilon,$$

The results of the regression equation follow in the next section. There are usually some problems of spatial autocorrelation related to these spatial regressions.

3.4 Spatial Autocorrelation

Spatial data is often subject to spatial autocorrelation. According to Rogerson (2001), this occurs when the value of a variable at one point in space is related to the value of that variable at another point due to the distance between these variables. This implies that the observations are not independent from each other and could affect the statistical analysis and lead to misinterpretation. In the case of this analysis, the closer two municipalities are to each other the more similar might their ability to increase food manufacturing workers be. For example, the closer two municipalities are, the more similar might their availability of input materials be. One effect of spatial autocorrelation is that it causes the sample size to be smaller than originally formulated. With a smaller number of observations the degrees of freedom are reduced and results are not as significant as they appear (Rogerson, 2001).

Three dummy variables accounting for sparsely populated regions, agricultural regions, city regions and large city regions were included in the original model to handle a potential autocorrelation problem. However, the dummies made no difference to the model whatsoever and were therefore disregarded. Apparently, the regional shift of the food industry in our model does not appear to display much spatial autocorrelation from studying the maps in figure 3.1.

4 Regression results and analysis

The model is estimated for three time periods and the results are displayed below.

Table 4.1 Regression output

	1992-1997	1997-2002	2002-2007	VIF
RSF _j (Dependent variable)	Coefficient (Robust std errors) ¹	Coefficient (Robust std errors) ¹	Coefficient (Robust std errors) ¹	For the period 2002-2007 ²
EMPF _j	-0.059 (0.049)	0.034 (0.057)	-0.067 (0.034)**	3.10
CF _j	19.21 (10.05)*	-18.10 (7.852)**	1.441 (7.061)	1.24
MANU _j	90.36 (42.66)**	-6.220 (56.02)	104.5 (100.3)	1,33
INPUT _j	0.075 (0.0534)	-0.043 (0.075)	0.118 (0.060)**	1,19
EMPTOT _j	0.001 (0.001)	-0.0001 (0.001)	-0.0006 (1.000)	2.99
SMALLF _j	67.89 (177.0)	321.8 (204.1)	-198.7 (203.9)	1,34
POP _{ACCESS}	0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)*	1,61
Constant	-106.2 (163.7)	-248.0 (183.5)	160.2 (179.5)	
R ²	0.06	0.03	0.32	
F-test (DF)	F(7,266)=1.13 Prob > F=0.34	F(7,272)=2.54 Prob>F=0.02	F(7,268)=14.07 Prob>F=0.00	
Number of observations	274	280	276	
Ramsey RESET test	F(3,263)=7.85 Prob>F=0.00	F(3, 269)=1.69 Prob > F=0.17	F(7, 268) = 6.25 Prob > F=0.00	

** Significant at 5% level, * Significant at 10% level

¹ White-Huber robust variance-covariance is used to obtain robust standard errors

² The VIF from the last time period is shown, although the values are consistent for all the time periods

The results above indicate a few problems with the model specification. The Ramsey RESET test suggests that the model is mis-specified. A model is mis-specified due omitted variables, an incorrect functional form or correlation between the explanatory variables. Unsurprisingly, there is collinearity between the number of employees in the food sector and all employees in a municipality. Nonetheless, subtracting one of these variables from the specification does not alter the model. Attempts have been made to adjust the functional form of the model but none

have been successful in increasing the accuracy. As there is some heteroskedasticity in the model indicated by the Breusch-Pagan / Cook-Weisberg test, robust standard errors have been applied in order to improve the model specification.

The difficulty of analyzing the regional shift as a measure of comparative advantages leads to model specification problems. If the change of employment in the food industry is used as the dependent variable instead, the results are similar but with a higher R^2 . The model therefore has a more difficult time explaining the change in employment measured as the regional shift, than it has explaining the change in food manufacturing employment measured in absolute terms. Since the signs and significance levels of the coefficients are very similar however, the regional shift can be used as the dependent variable.

Regardless of the problematic model, the estimations have shown some interesting results. This model seems to explain the influences on regional comparative advantages during the latest time period to a greater extent than during the earlier time periods. Starting by analyzing the last time period (2002-2007), it can be observed that the food industry is not growing where it is already large in absolute terms as mentioned earlier. The location quotient is positive suggesting it has some impact on the growth of employment in food manufacturing, however the effect is not large enough to be significant.

The estimator of the input variable is positive and significant. During recent years, the importance of domestically produced food has increased, which have resulted in a growing demand for national input products for food processing firms. Existence of producers of input-products is a decisive factor of the localization of food manufacturing firms if they prefer not to import. Since firms supplying raw materials for food manufacturers generally cannot move to their markets, the food manufacturing firms need to move towards their suppliers in order for transportation costs to be reduced. The coefficient of the accessibility to the population variable is also positive and significant. This verifies the notion that the home market has become increasingly important. Proximity to the market decreases transportation costs and is therefore positively associated with the location of food manufacturers.

Turning to the first time period (1992-1997), it can be recognized the fit of the model is poor. This time period exhibits some abnormalities in the form of outliers of the dependent variable. In contrast to the middle period (discussed below), these extreme values are municipalities

where the employment in the food industry is shrinking. These outliers reduce the general fit of the model. The estimator of the location quotient is significant and positive for this time period. The signs of the coefficients suggest that on the one hand, there are no comparative advantages of the food industry in municipalities where it is originally large (such as highly populated and/or large municipalities), while on the other hand, there are comparative advantages for food industries where this industry is highly concentrated compared to other industries in that region. Moreover, a positive and significant value for the estimator of the share of manufacturing workers is obtained. A larger pool of manufacturing workers has a positive influence on employment growth in the food manufacturing sector.

The middle period (1997-2002) of the analysis is the only period where the food industry is actually increasing in the country as shown in figure 3.2. These estimation results differ from the previous results, largely due to a few outliers (see figure 7.2 in appendix). These municipalities seem to be driving a restructuring of the food industry. The model specification does not explain the behavior of the dependent variable very well for the middle period of the analysis. The five outlying municipalities show extremely high values of the dependent variable. Most of the outliers also have very high location quotients and a fairly high number of input suppliers. The regression, however, yields a significant and negative coefficient of the location quotient. The food manufacturing industry seems to be shifted into these outlying municipalities to some extent. The reason for the poor results of the middle period is most likely that the extreme values are the main forces of the characteristics of the food industry in this time period.

The outlying municipalities are characterized by the growth of a few large firms. These firms have benefited from internal economies of scale as they have grown considerably in size during the middle time period. Furthermore, most of these municipalities, as well as the nation on average, have increased their export intensity ($\frac{\text{export}}{\text{turnover}}$), during the period between 1997 and 2002. Both Sweden's entrance into the EU and the implementation of the WTO Agreement on Agriculture in 1995 had a huge impact on a reduction of trade barriers (WTO).

These results imply that there exist agglomeration economies in the first time period. The relative concentration of food manufacturing firms and the relative size of the pool of manufacturing workers suggest that external economies of scale are important for the food

processing industry during this period. However, during the last period, the concentration of food processing firms seems to be of little importance and it is even negative for the middle period. The maps in figure 3.1 and the HHI index hinted of little concentration of the industry. Considering the three time periods covered, there is no apparent tendency towards a more concentrated food manufacturing industry. It seems that agricultural factors and urban factors are both driving the localization pattern of firms.

The importance of locally produced food products is increasing. External economies of scale might become more important than internal economies of scale since the demand for small-scale products is increasing. The regression model for the last time period (2002-2007) is the most accurate, signifying that input producers are the most important determinant for comparative advantages of food manufacturing industry growth along with accessibility to the market. Since these two variables are not located in the same areas, input- versus output transport costs will be a decisive factor for food manufacturing firms' localization decision.

5 Conclusion

The regression model was a relatively poor predictor of factors determining the regional shift of food manufacturing employees in Swedish municipalities, at least for the first two periods. These results are largely due to a few outliers where much of the movement of the industry is taking place and to the difficulty in analysing the regional shift component. The variables did however explain the determinants of regional comparative advantages for the last period fairly well. The results indicate that both firms producing input products and accessibility to the output market are important variables influencing regional growth and comparative advantages in the food industry.

The manufacturing industry is characterized by internal economies of scale according to Krugman (1991). Nevertheless, in recent years mass production of food products is becoming less attractive. This could be one explanation as to the reason why both the availability of input products and the importance of the home market has become significant in later years. The hypothesis that external economies of scale are important for the food manufacturing industry is only partly confirmed. There seems to be other forces not included in the model that could be of importance.

The Swedish pattern of municipalities exhibiting comparative advantages in the food processing industry is more or less random as shown by the maps in figure 3.1. There is no noticeable trend towards a more concentrated food manufacturing industry as measured by the concentration of firms and workers. The estimation results show little signs of agglomeration economies as a determinant force of comparative advantages except for during the first time period, although there are some clustering benefits related to a firm's inputs and output market. For this reason, some properties of external economies of scale seem to be of importance.

Ohlin's (1933) division of external economies of scale due to locational economies and urbanization economies might be justified. It is proposed that the strength of the local externalities might differ, which seems highly applicable to the food manufacturing industry. The early locational theory suggesting that industries might be trapped to certain geographical areas also gains some support from the results. According to this theory, comparative advantages of regions depend upon differences in the supply of lasting resources. Perhaps these forces are very strong in the food processing industry and the forces in play by the complementary theory of the new economic geography are weaker.

Interesting research would be to use turnover change as a measurement of regional comparative advantages rather than employment change. Furthermore, the application of the input-output method in analyzing regional comparative advantages in food industries could yield interesting results.

6 References

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7 Appendix

Table 7.1 20 municipalities with largest regional component for the food industry, 92-07

Municipality	Food industry regional component 92-97	Municipality	Food industry regional component 97-02	Municipality	Food industry regional component 02-07
JÄRFÄLLA	400	HANINGE	786	VÄSTERÅS	404
SKARA	359	GÖTENE	695	BOTKYRKA	328
KRISTIANSTAD	299	LINKÖPING	536	FALKENBERG	264
FALKÖPING	255	KRISTIANSTAD	375	GÖTENE	252
HUDDINGE	253	HELSINGBORG	278	LIDKÖPING	249
MÖLNDAL	234	HALMSTAD	194	HUDDINGE	228
UPPLANDS-VÄSBY	212	LANDSKRONA	122	JÖNKÖPING	210
LIDKÖPING	205	LAHOLM	100	SOLNA	178
SÖDERTÄLJE	157	SIGTUNA	90	ESKILSTUNA	134
GÖTEBORG	157	VÄNERSBORG	90	HALMSTAD	132
VÄXJÖ	140	STAFFANSTORP	85	ÖRNSKÖLDSEVIK	120
ESLÖV	131	ÖRKELLJUNGA	82	VIMMERBY	108
LJUSNARSBERG	129	ÄLVSBY	81	KARLSTAD	108
GÖTENE	128	SUNDSVALL	78	SÖLVESBORG	97
LULEÅ	128	HABO	73	ÖRKELLJUNGA	95
SOTENÄS	126	SKURUP	72	SKELLEFTEÅ	89
TOMELILLA	119	MÖRBYLÅNGA	67	MOTALA	85
ÄNGELHOLM	116	UMEÅ	66	LANDSKRONA	83
VIMMERBY	115	MARK	65	LINDESBERG	82
KATRINEHOLM	113	LIDKÖPING	65	LUDVIKA	78

Figure 7.2 Boxplot of outliers of the middle period (1997-2002)

