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Market Power and European Competition in the Swedish Food Industry

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Abstract

This paper investigates the existence of market power in the Swedish food and beverage industry and how market power has been affected by European competition (the Single Market and Swedish EU membership). The study makes use of a census of some 500 firms for the period 1990–2002. The results show that firms in the Swedish food and beverage industry do enjoy some market power, the degree of which varies significantly across the sectors of the food and beverage industry. Increased foreign competition has contributed to reducing market power in sectors that were protected by tariff and non-tariff barriers to trade prior to Swedish EU membership.

Keywords: Market power, competition, internal market, Sweden, food and beverage

JEL-Classification: F15, L11, L66, C33

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1 Introduction

An important argument for Swedish membership in the EU in 1995 was an expected reduction in prices resulting from increased competition and reduced market power of firms. The effect was expected to be particular important in the food and beverage industry since the industry was mainly operating on a protected domestic market with high prices compared to EU countries. Moreover, the industry was one of the largest in Sweden in terms of employment and production value. The expected effects on prices from the EU membership had two main sources. First, increasing imports, as impediments to imports from the EU were reduced, were expected to intensify competition. Second, potential import competition and entry into the market were expected to discipline Swedish firms' pricing behaviour, forcing them to reduce their price-cost margins.

The purpose of this paper is to test for the existence of market power in the Swedish food and beverage industry and assess the influence of foreign, in particular European competition, on market power. Firms' market power is measured by their price-cost mark-up. More specifically, the hypothesis tested is that weak competition allows firms to exercise some degree of market power to raise prices above marginal costs and that competitive pressure has increased, thus pushing prices and mark-ups down, after Swedish membership in the EU. In addition, a test is conducted to determine the extent to which changes in firms' pricing behaviour are linked to reductions in barriers to trade, by comparing protected to open sectors. Lastly, how ownership affects pricing is investigated.

The mark-up is estimated for a panel of Swedish firms between 1990 and 2002. The analysis reveals important differences across the sectors within the industry and differences in initial barriers to trade among them are used to identify the effect of import competition. In contrast to papers focusing on the effects of the single market program (SMP), this paper investigates the effects of reductions of non-tariff barriers (NTBs) and tariffs. The effect of import competition can be expected to be relatively important in sectors with high initial barriers to trade; hence the potential price

reduction in these sectors is larger than in sectors that were open to trade before 1995, *ceteris paribus*. Further, the time series dimension of the data is used to analyse the evolution of the mark-ups over time. The evolution both on industry and sector levels is evaluated. As the ownership structure in the food and beverage industry is different from that of the rest of the manufacturing industry, it is important to take the effect of ownership on mark-ups into account in the analysis. Some sectors, for example, the dairy sector, are dominated by producer cooperatives that might maximize input prices for their members but not profits, which would result in lower mark-ups, since firms that maximise input prices would have higher costs compared to firms that maximise profits.

The rest of the paper is structured as follows. Section 2 discusses the Swedish integration into the EU and the effects on the food and beverage industry, comments on previous studies and presents the empirical model and the data. Section three analyses the estimation results in terms of the differences across sectors, followed by the evolution of average mark-up in the industry over time and of the dynamics within the industry. Section 4 summarises the main results.

2 Background

Swedish membership in the EU 1995 implied important policy changes that affected the market conditions for Swedish firms. First, remaining tariffs on intra-EU trade were removed. Second the SMP aimed at integrating the EU-countries markets by the harmonisation of regulations and reductions of non-tariff barriers to trade in order to facilitate trade and reduce price differences within the EU. Third, Swedish tariffs towards non-EU countries increased somewhat as the EU common external tariff was implemented. In addition, the food and beverage industry was indirectly affected by the adoption of the Common Agricultural Policy (CAP), which affected input markets and hence input prices.

The policy changes were expected to increase trade and competition, with the most significant effect in sectors with high initial barriers to trade and in concentrated

sectors where domestic competition was limited. Moreover, enhanced import competition was expected to have a relatively large disciplinary effect on the pricing of firms in small countries compared to large ones (Hoekman et al. 2004). In large countries domestic competition is relatively more important since the number of competing firms will be larger in the domestic market than in a small country. Other important factors affecting competition are impediments to entry such as high sunk entry costs, which have an important dual impact on firms' mark-ups. First, high entry costs deter the entry of new firms, thus reducing competition and allowing firms to maintain positive price-cost mark-ups. Second, firms that do enter will require a higher mark-up to recover the entry cost. Foreign firms may have higher entry costs than domestic ones, hence they will only enter if they can recover the entry cost by charging a higher mark-up. The entry cost for foreign firms was expected to decrease As a result of the EU-membership, implying that the differences between foreign and domestic firms should shrink.

A reduction in barriers to intra EU trade creates opportunities for increased exports and a reduction in input prices for the food and beverage industry, as inputs can be imported from other EU countries. As the focus of this paper is the Swedish market for food and beverage products, and exporters are not found to be significantly different from non-exporters in the empirical analysis in section 3, the effect of export activity on mark-up will not be analysed.

In general, the tariffs on food and agricultural products were lower in Sweden than in the EU prior to EU membership. However, the effect of the adjustment to the EU common external tariff in trade with third countries is ambiguous. There are several reductions in the EU import tariffs as a result of trade preferences for developing countries. Moreover, EU-15 was the most important origin for Swedish imports before 1995, with an import share in agricultural and food products above 50 % (SOU 1997)

2.1 The Swedish food and beverage industry in the Internal Market

Swedish membership in the EU was preceded by measures to reduce barriers to trade with the EU. In 1973 a free trade agreement between the EU and the EFTA countries came into force. The agreement only covered a very limited number of goods in the food and beverage industry and goods traded without tariffs (for example chocolate and sugar confectionery, macaronis, pastry and ice-cream) were subject to export subsidies and import duties to compensate for differences in agricultural prices.[1] In the fish processing sector firms were not protected by tariffs as Sweden granted duty-free access to the Swedish market for fish products from the EU, but EU tariffs prevented Swedish firms from exporting to the EU. The creation of the European Economic Space in the early 90s further reduced barriers to trade between Sweden and the EU, but to a limited extent in the food and beverage industry where tariffs sheltered Swedish producers until 1995. The high tariffs insulated Swedish firms from import competition but at the same time high tariffs on agricultural products forced producers in the food and beverage industry to use Swedish inputs. The reduction in trade barriers was therefore expected to both increase the degree of competition in the final product market and reduce the prices of inputs.

In the early 90s (1992, 1993) the Swedish krona was devaluated several times reducing import competition even more, but since the end of 1993 the exchange rate between the Euro and Swedish krona has been rather stable. Sweden experienced a recession in the beginning of the 90s, which may have reduced capacity utilization and increased production costs, thereby reducing the estimated mark-ups. The food industry might be less sensitive to variations in business cycles than other manufacturing industries, since demand for food products is less affected by business cycles than demand for other manufactured products.

[1] The import duties on these products were not barriers to trade in the sense that they were implemented to compensate domestic producers for higher input prices. However, they impose an administrative burden on importers and may thus be considered a non-tariff barrier to trade.

2.2 Related studies

Empirical studies show that import competition reduces mark-ups (Tybout 2003; Lundin 2004), but evidence of a pro-competitive effect of the SMP in the EU is scant. Analysing mark-ups of 17 sectors in ten EU countries for the period 1981–1999, Badinger (2004) concludes that the effect on mark-ups has been limited, even though he finds significant variations among the sectors analysed.[2] Studies of individual countries tend to give a more positive view of the effects. They indicate that competition has reduced mark-ups in sectors protected by various forms of non-tariff barriers (NTB) before the implementation of the SMP. In the case of Sweden the impact of the SMP on mark-ups has been examined by Gullstrand and Johansson (2005). They find that the single market program increased competition, thus reducing mark-ups, in most sectors. However, their results indicate that firms in sectors protected by NTBs, so-called *sensitive* sectors within the food and beverage industry, were not affected and behaved competitively both prior to and after Swedish EU membership. That is, competition in the food and beverage industry was sufficient to keep firms from pricing with a mark-up in the sectors with NTBs. A possible explanation might be that the definition of *sensitive* sectors is not that precise and does not capture sectors where competition has increased. Furthermore, significant barriers to trade still existed in the food and beverage sector in the mid 90s (e.g. in 1994). Gullstrand and Johansson (2005) investigate the effects of the SMP, hence they focus on NTBs, but many tariffs within the food and beverage sector were only eliminated in 1995. This paper address this issue by defining sensitive sectors as sectors with significant barriers to trade (NTBs and/or tariffs) prior to 1995, and by comparing a period when tariffs were abolished to the period before 1995. The effect of import competition (e.g. import penetration), is analysed by Lundin (2004), who finds that import competition reduced mark-ups in the Swedish manufacturing sector in the 90s.

[2] Sauner-Leroy (2003) analyses the evolution of mark-ups in 11 EU countries for the period 1987–2000 and finds decreasing mark-ups in the period before1993 and increasing mark-ups in the period after 1993. He attributes the rising mark-ups to efficiency gains and argues that the SMP has had a positive effect on efficiency and on competition.

In addition, the estimated mark-up in the food and beverage industry is significant and positive, that is, the price-cost margin is above one.

The SMP has been shown to have a competitive effect in *sensitive* sectors of the Italian manufacturing industry (Bottasso and Sembenelli 2001). One important measure within the SMP was the harmonisation of regulations to facilitate increased trade and integration of EU markets. In the food and beverage industry Vancauteren and Frahan (2004) show that the harmonisation of regulations has increased trade.

2.3 Empirical model

The mark-up of firms is estimated in order to analyse their market power and the effects of increased competition on market power. The mark-up has been frequently used to measure competition, but since estimated mark-ups usually reflect industry averages, increased competition does not necessarily reduce the estimated mark-up. If the increasing competition forces less productive firms, with relatively low mark-ups to exit, while more productive firms, with higher mark-ups, gain market shares, the average mark-up may increase (Boone et al. 2005). However the mark-up of individual firms should not increase. In order to reduce this problem, the analysis is conducted on a disaggregated level, in both the full sample of firms and a sample restricted to large firms, where exit and entry will affect the average mark-up to a lesser extent. Further, efficiency gains and reductions in input prices may enable firms to price with a constant mark-up even if competition increases and prices in the product market are reduced. Therefore, the analysis is contrasted to studies of the productivity evolution in the Swedish food and beverage industry, and the evolution of input prices is discussed.

In this paper the approach to estimating the mark-ups is based on a method developed by Roeger (1995), which is an extension of the work of Hall (1988). The main contribution by Roeger (1995) is that he shows how the differences between the primal (production-based) Solow residual and the dual (price-based) Solow residual can be used to eliminate the unobservable productivity shock in order to retain an unbiased estimate of the mark-up. Roeger (1995) used two production factors (labour

and capital), but we also add raw materials, since the estimates may be biased if raw materials are not included (Oliveira Martins and Scarpetta 1999). An additional advantage of the method is that nominal values of the variables can be used. However, a possible drawback of the method is that it relies on an assumption of constant returns to scale. Increasing (decreasing) returns to scale will bias the estimated mark-up downward (upward). Estimating a Cobb-Douglas production function for the Swedish food and beverage industry, Gullstrand and Jörgensen (2005) found no significant deviations from the constant returns to scale assumption, thus justifying the used estimation technique. In addition, deviations from the assumption of constant returns to scale will not bias the interpretation of the estimates when comparing the same industries in different periods, as long as the extent of economies of scale does not change over time. The results in Tybout (1992) and Krishna and Mitra (1998), however, suggest that trade liberalization may affect the returns to scale.

Assume that each firm produces output (Q) according to a homogenous production function F using three inputs: Labour (N), Capital (K) and materials (M). Θ_{it} is a Hicks-neutral productivity term.

$$Q_{it} = \Theta_{it} F\left(N_{it}, K_{it}, M_{it}\right) \tag{2.1}$$

Under the assumption of constant returns to scale and perfect competition on input markets, but imperfect competition in product markets, the primal Solow residual is defined as the difference between output growth and input growth weighted by their shares in sales.[3]

[3] Detailed calculations are included in the appendix.

$$SR = \frac{\Delta Q_{it}}{Q_{it}} - \alpha_{Nit}\frac{\Delta N_{it}}{N_{it}} - \alpha_{Mit}\frac{\Delta M_{it}}{M_{it}} - \left(1-\alpha_{Nit}-\alpha_{Mit}\right)\frac{\Delta K_{it}}{K_{it}} =$$

(2.2)

$$\beta_{it}\left(\frac{\Delta Q_{it}}{Q_{it}} - \frac{\Delta K_{it}}{K_{it}}\right) + \left(1-\beta_{it}\right)\frac{\Delta \Theta_{it}}{\Theta_{it}}$$

Where $\alpha_J, J = N, M$ is the cost of input *J* as a share of sales $\alpha_{Jit} = \frac{P_{Jt}J_{it}}{P_{it}Q_{it}}$, P_{Jt} is the price of input *J* and P_{it} is the price of the produced good, The market power of firm *i* at time *t* is shown by the β_{it} coefficient, which is the Lerner index defined as $\beta_{it} = \frac{P_{it} - MC_{it}}{P_{it}} = 1 - \frac{1}{\mu_{it}}$ where MC_{it} is the firm's marginal cost and μ_{it} is the price-cost mark-up $\mu_{it} = \frac{P_{it}}{MC_{it}}$

The problem with estimation of the mark-up based on equation (2.2) is that the estimated coefficients will be biased, if the productivity shock is partly observable to the firm but not to the econometrician. Roeger (1995) suggests that the dual Solow residual (DSR) could be used to circumvent this problem.

$$DSR = \alpha_{Nit}\frac{\Delta P_{Nit}}{P_{Nit}} + \alpha_{Mit}\frac{\Delta P_{Mit}}{P_{Mit}} + \left(1-\alpha_{Nit}-\alpha_{Mit}\right)\frac{\Delta R_{it}}{R_{it}} - \frac{\Delta P_{it}}{P_{it}} =$$

(2.3)

$$-\beta_{it}\left(\frac{\Delta P_{it}}{P_{it}} - \frac{\Delta R_{it}}{R_{it}}\right) + \left(1-\beta_{it}\right)\frac{\Delta \Theta_{it}}{\Theta_{it}}$$

R is the individual firm rental price of capital defined as $R_{it} = P_I\frac{r+\delta_{it}}{1-t}$; P_{Nit} and P_{Mit} are the prices of labour (wage) and materials, respectively. The productivity shock is part of both the SR and the DSR, so subtracting the DSR (2.3) from the SR (2.2) cancels it out.[4]

[4] For other approaches to correcting for the bias in mark-up estimates see Levinsohn (1993) and Harrison (1994)

$$(2.4)\quad \left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\alpha_{Nit}\left(\frac{\Delta N_{it}}{N_{it}}+\frac{\Delta P_{Nit}}{P_{Nit}}\right)-\alpha_{Mit}\left(\frac{\Delta M_{it}}{M_{it}}+\frac{\Delta P_{Mit}}{P_{Mit}}\right)-\left(1-\alpha_{Nit}-\alpha_{Mit}\right)\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)=$$
$$\beta_{it}\left[\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]$$

To allow estimation of the mark-up directly, the relation between the Lerner index and the mark-up is used to rewrite equation (2.4).

$$(2.5)\quad \left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)=$$
$$\mu_{it}\left[\alpha_{Nit}\left(\left(\frac{\Delta N_{it}}{N_{it}}+\frac{\Delta P_{Nit}}{P_{Nit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right)+\alpha_{Mit}\left(\left(\frac{\Delta M_{it}}{M_{it}}+\frac{\Delta P_{Mit}}{P_{Mit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right)\right]$$

Thus, the data required to estimate the mark-up is nominal sale, value of capital, wage bill and nominal value of materials. For practical purposes equation (2.5) will be shortened by denoting the left-hand side ΔY_{it} and the terms in brackets on the right-hand side ΔX_{it}. Hence, the estimated mark-up is inferred from μ in the regression:

$$(2.6)\qquad \Delta Y_{it}=\mu\Delta X_{it}$$

The variables used to estimate the model are defined as follows:

$$\Delta Y_{it}=\Delta\ln(\text{sale})-\Delta\ln(\text{value of capital})$$
$$\Delta X_{it}=\alpha N_{it}\left[\Delta\ln(\text{wage bill})-\Delta\ln(\text{value of capital})\right]+$$
$$\alpha M_{it}\left[\Delta\ln(\text{raw material cost})-\Delta\ln(\text{value of capital})\right]$$

$$\alpha N_{it}=\text{Labour cost share in output}=\frac{\text{wage bill}}{\text{sales}}$$
$$\alpha M_{it}=\text{Raw material cost share in output}=\frac{\text{raw material cost}}{\text{sales}}$$

That is, ΔY_{it} is the growth of sales per unit of capital and ΔX_{it} is the growth rate of inputs weighted by input shares per unit of capital. As in Gullstrand and Johansson

(2005), the cost of capital is assumed to be 7 %.[5] That is, the value of capital is $0.07 \times \text{capital stock}$, where the capital stock is defined according to the perpetual inventory method. The book value of fixed assets in the first year is used as the initial value. All variables are based on nominal values, which is an advantage since we do not need to deflate any variables.

A value of μ equal to one indicates that there are no mark-ups, that is, firms behave competitively. A value above one, on the other hand, indicates positive mark-ups, that is firms exercise some market power, enabling them to charge prices above marginal costs.

2.4 Data and definition of sensitive sectors

The dataset consists of a yearly census of Swedish firms in the food and beverage industry, collected by Statistics Sweden, and covers the years 1990-2002. We have excluded small firms (observations with less than 10 employees and firms with less than 20 employees for all years) and firms that are observed for less than three consecutive years. The exclusion of small firms is necessary since they are not included in the census for all years and the data quality is poor. The number of small firms is significant but in terms of employment and sales they constitute a very small share of the industry; hence our sample has a good coverage as can be seen from column 4 of Table 1. The data set includes detailed information on capital, employment, investments, ownership, exports (firms with more than 49 employees) and so on.

So-called *sensitive* sectors are those sheltered initially from foreign competition and expected to be affected by increased competition as a result of reduced barriers to trade. Two classifications are used to identify them. The first is from EFTA (1992) and

[5] It could be argued that the capital cost should be calculated for each firm since the composition of capital is not the same across firms. However, using firm-specific capital costs implies that a large number of firms have to be omitted from the sample. Robustness checks indicate that allowing the capital cost to vary over time to capture variations in inflation and interest rates does not affect the results significantly.

identifies sectors with high NTBs. In this paper only sectors classified by EFTA as highly *sensitive* are defined as *sensitive* to capture the effects in the sectors with the highest degree of protection. To identify (4-digit NACE) *sensitive* sectors the EFTA study uses a survey of the degree of prevalence of non-tariff barriers to trade such as technical barriers, administrative barriers and frontier formalities. Thus, it provides a detailed classification of sectors.[6] Since the EFTA-classification of sensitive sectors disregards tariffs, other classifications are possible. Studies that identify sensitive sectors based on tariffs do not use a detailed (4-digit) sector analysis and they do not take into account the presence of non-tariff barriers. The Swedish classification is based on SOU (1997) and Sveriges Livsmedelsindustriförbund et al. (1993) which identify sectors protected by tariffs prior to 1995. Sectors (mostly 3-digit NACE rev.1) mentioned as *sensitive* in at least one of the two studies are treated as sensitive in this paper. The fruit and vegetables sector is partially protected but the studies do not identify which parts are protected and which are not. Therefore, the sector is classified as sensitive. A detailed list of the classifications is given in the appendix.

Table 1 Structure of the Swedish food and beverage industry 1990–2002

Sector (NACE rev. 1)	Observations	(share in sensitive)[1]	firms	Employees (average)	Cooperative share of sale	Sample coverage[2]
Meat preparation (151)	1141	(100)	147	159	48	97
Fish processing (152)	297	(100)	39	55	5	94
Fruit & Vegetables (153)	240	(0)	40	233	5	95
Vegetable & animal oils (154)	57	(0)	12	364	20	87
Dairy products (155)	199	(100)	22	609	75	97
Grain milling (156)	199	(0)	24	74	62	80
Animal feeds (157)	67	(100)	9	97	26	80
Other food products (158)	1859	(12)	240	121	14	97
Beverages (159)	209	(44)	29	382	0	99
Total	4268	(47)	530	169	35	92

Notes: Some firms change sector, so the total number of firms is less than the sum of firms over sectors. [1] Sensitive sectors are defined at the 4-digit level, according to the EFTA classification. [2] The samples share of total employment in the database, which consists of a census of firms with at least 10 employees.

[6] As the classification in the EFTA (1992) paper uses NACE 1970, the classification had to be transformed to NACE rev. 1 using a concordance table from Eurostat (1996). NACE rev. 1 sectors mainly allocated to non-sensitive or medium sensitive sectors in NACE 1970, have been classified as non-sensitive.

The food and beverage industry is divided into 9 sectors on the 3-digit level of NACE rev. 1. The largest sectors in terms of value of production are meat preparation and dairy products, but the largest numbers of firms and observations are in the other food products sector, which consists of a rather heterogeneous group of firms in markets with a relatively high value added (SOU 1997). The largest group of firms within the sector is bakeries, but it also includes chocolate producers and processing of tea and coffee. Table 1 shows key indicators for these sectors. The distribution of firms and their average size varies substantially across sectors in the food and beverage industry. The average size of firms, in terms of employment, is above 600 in the dairy sector while it is 55 in the fish processing sector. Table 1 also shows that almost all 4-digit sub-sectors within a 3-digit sector are either sensitive or non-sensitive (EFTA-classification), the only variation within 3-digit sectors being in other food products and beverages. The presence of cooperative owners is significant in several sectors, especially the dairy and grain milling sectors, where their share of sales is above 60 %. The last column in Table 1 shows that the coverage of the regression sample is high compared to the whole database, which consists of a census of firms in the food and beverage sector with more than 10 employees.[7] The vast differences between sectors clearly point to the importance of allowing mark-ups to vary across sectors.

Table 2 shows key indicators by sectors for the period prior to EU accession in 1995 and the period after. It provides evidence that both exports and imports have increased substantially as shares of production and consumption, respectively, in all sectors except the fruit and vegetables sector. The increases in both exports and imports are sizable; even so the total of industry imports is about twice as large as that of exports. The extensive increase in the exports implies that a growing share of the firms (with employment > 49) is engaged in export activity.[8] The import and export figures in the fish processing sector should be interpreted carefully because of re-export of Norwegian fish products from Sweden.[9]

[7] Comparing the number of employees to aggregated industry statistics is not fruitful since some firms have employees in several sectors.
[8] The share of firms, with more than 49 employees, exporting was 54 % in 1990 and 79 % in 2002.
[9] 67 % of the Swedish fish exports in 2003 is estimated to be re-export of Norwegian fish products conducted by foreign firms (Hammarlund 2005).

Further, Table 2 reveals a clear trend towards smaller firms on average, with two exceptions, the vegetable and animal oil and animal feeds sectors. In particular the former sector deviates from other sectors with a large increase in average firm size. The last two columns of Table 2 shows that the concentration, measured as the two largest firms' share of domestic consumption in each sector, is high. In several sectors the two largest firms account for more than 50 % of the domestic market. The evolution of concentration over time varies across the sectors.

Table 2 Development in the food and beverage industry (averages in percent)

	Import penetration[1]		Export/ production		Employees (average)		Concentration[2]	
Sector	90-94	95-02	90-94	95-02	90-94	95-02	90-94	95-02
Meat preparation	6	14	3	6	185	145	26	33
Fish processing	77	102	40	105	60	52	18	20
Fruit & vegetables	40	40	11	12	313	191	42	42
Vegetable & animal oils	22	42	11	27	271	432	52	68
Dairy products	4	8	2	7	660	578	62	66
Grain milling	29	38	6	10	92	64	32	26
Animal feeds	15	20	2	3	91	100	36	50
Other food products	18	26	13	21	157	106	20	20
Beverages	22	31	7	26	407	367	56	36

Notes: Exports and imports used to calculate import penetration and export share of production are extracted from trade statistics and matched to NACE rev. 1 categories**.** [1]Import share of domestic consumption. [2]The two largest firms' share of domestic consumption.
Sources: Statistics Sweden, own calculations.

3 Results

The idea that enhanced competition reduces prices is based on an assumption that firms have some degree of market power and can exploit it to price above marginal costs. The first step of the analysis is to test whether firms in the sectors of the food and beverage industry exhibit positive mark-ups (e.g. above one). Second, the development of the average industry mark-up is investigated to detect possible trends common to the whole industry. However, aggregation across sectors is problematic as it may conceal important reallocation effects within the industry. Hence, the evolution of mark-ups on the sector level is also analysed. To cast light on the importance of the

reduction of barriers to trade in explaining the development of sector mark-ups, protected, *sensitive*, sectors are compared to open, non-sensitive, sectors.

To control for possible differences between new small firms and larger firms with an established position on the market, the regression analysis is conducted in two samples; one including all firms and a second including only firms with more than 49 employees. The estimated coefficients from the latter sample are less affected by exit and entry and allow us to focus on the impact on firms staying in business. The rationale for this is that average mark-up may rise as a result of increased competition if firms with low mark-ups exit. Ignoring this might lead us to the incorrect conclusion that the competitive pressure has been reduced, while it in fact has increased.

3.1 Sector analysis of mark-up

Mark-ups are likely to vary across sectors of the food and beverage industry as a result of differences in market structure and production technology. A high degree of concentration, together with limited import penetration, indicates weak competition and is expected to result in high mark-ups.

To analyse the average mark-up of sectors in the food and beverage industry, the mark-up is interacted with sector dummy variables, and to control for time-specific factors common to all firms, for example business cycles and variation in inflation, time fixed effects are added. In addition, firm fixed effects are introduced to control for unobservable firm-specific factors constant over time.

$$(3.1)\ \Delta Y_{ijt} = \beta_j \sum_{J=1}^{J=9} \Delta X_{ijt} * D_j + \beta_F \Delta X_{ijt} * D_F + \beta_{Coop} \Delta X_{ijt} * D_{Coop} + \varepsilon_{ijt} \text{ with } \varepsilon_{ijt} = \alpha_i + \lambda_t + u_{ijt}$$

Where D_j is a set of sector dummy variables and α_i, λ_t are fixed firm and time effects, respectively. The estimated β coefficients indicate the mark-up in each sector *j*. A value of one would indicate perfect competition and a value significantly above one would indicate imperfect competition. D_F and D_{Coop} are dummy variables equal to one

if the firm is foreign owned or a cooperative, respectively. They indicate the deviations of foreign and cooperative owned firms from private Swedish owned firms and are included to test whether ownership has a significant impact on prices.[10]

The set up of the model implies that average mark-ups are constant over time but allowed to vary across sectors. Before the full model is estimated in equation (3.1) it is estimated without interaction of the mark-up (e.g. ΔX_{ijt}) with the industry dummy variables, hence the estimated coefficient shows the average industry mark-up for the period 1990 – 2002. The estimation results are shown in Table 3. Note that the asterisks on the sector mark-up coefficients in the table indicate a significant difference from one. The results in Table 3 indicate that the average industry mark-up is above one in the sample with all firms, thus implying a positive mark-up and the existence of market power in the whole industry during the period examined. The average mark-up of large domestic firms (employment > 49), on the other hand, is not significantly above one. For the larger firms, foreign ownership is an important explanation for differences among firms, since only foreign-owned firms exhibit a positive mark-up.

Table 3 (columns 3-4) clearly indicates that firms in most sectors have some degree of market power, which enables them to raise prices above marginal costs, and that the variations are significant across the sectors, illustrating the importance of estimating the mark-up at a disaggregated level. The sectors where firms do not seem to benefit from market power are the meat preparation, fruit and vegetables and animal feeds sectors with mark-ups close to one. Note that larger firms in the meat preparation sector are able to charge prices above marginal costs. A significant share of the large firms in the sector is made up of producer cooperatives that enjoy a dominant position in the market, which could explain the differences between the large firms and all firms (Sveriges Livsmedelsindustriförbund et al. 1993). The mark-up is relatively large in the other food products sector, which could be expected since firms in the sector have a relatively high value added. The high mark-up in the fish processing sector is

[10] Mark-up on the domestic market may differ from mark-up on export markets, but, since exporters on average are not different from non-exporters in terms of mark-up, we do not control for export activity.

less obvious since the concentration in the sector is low and the average firm size is small, indicating low sunk entry costs. Between 1990 and 2002 the number of firms was small (9 firms with more than 49 employees). Prior to EU membership the sector was protected by NTBs, even though tariffs on import from the EU were removed in 1973, forcing the sector to restructure. It might be that firms are relatively efficient and that the limited number of competitors reduces the competitive pressure from domestic firms.

Table 3 Estimated average mark-up by sectors (1990–2002)

	all	emp>49	all	emp>49
Mark-up	1.091***	1.043		
	[0.023]	[0.041]		
Meat preparation			1.020	1.047***
			[0.046]	[0.012]
Fish processing			1.101***	1.147***
			[0.014]	[0.038]
Fruit & Vegetables			0.948	0.875
			[0.092]	[0.098]
Vegetable & animal oils			1.072**	1.081***
			[0.036]	[0.029]
Dairy products			1.082**	1.074*
			[0.036]	[0.039]
Grain milling			1.063*	1.136***
			[0.038]	[0.045]
Animal feeds			1.028	1.021
			[0.018]	[0.018]
Other food products			1.148***	1.124***
			[0.024]	[0.025]
Beverages			1.086***	1.085*
			[0.021]	[0.051]
Foreign ownership	0.035	0.106**	0.033	0.045
	[0.032]	[0.047]	[0.035]	[0.032]
Cooperative ownership	-0.041	0.036	0.017	0.043*
	[0.029]	[0.041]	[0.040]	[0.026]
Firm effects	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
Observations	3680	1550	3680	1550

Robust standard errors are within brackets. * Significant at 10 %, ** Significant at 5 %, *** significant at 1 %. Asterisks indicate significant differences from one, except for ownership variables.

The results in the first two columns of Table 3 do not indicate that cooperatives on average are different, in terms of mark-up, from other domestic firms. However, among the larger firms foreign-owned firms display higher average industry mark-up than Swedish-owned private firms. When the mark-up is allowed to vary across

sectors, the positive effect of foreign ownership on the mark-up disappears. Among the larger firms, cooperative firms exhibit higher mark-ups. Thus the indication is that foreign firms are more present in sectors with relatively high mark-up, since their average industry mark-up exceeds that of Swedish owned firms. When differences across sectors are controlled for, the mark-up of foreign-owned firms is not significantly higher than the mark-up of Swedish owned firms. Cooperatives, on the other hand, are present in sectors with relatively low mark-ups. Their average industry mark-up is not different from private firms, but they display a higher mark-up than the latter when mark-up is allowed to differ across the sectors. The results so far do not establish any clear-cut relation between barriers to trade, concentration and average size of firms. But the results only illustrate the average mark-up for 1990–2002, and if enhanced European competition had affected mark-up, it should have changed during the period and this is not disclosed above.

3.2 Dynamics of the mark-up and the impact of European Integration

Swedish EU membership and the SMP increased real and potential competition and mark-ups are therefore expected to decrease after 1995 as compared to the period before. The change may not be immediate, since Sweden has had a transition period for the implementation of EU regulations in some areas and foreign firms might need some time to enter into the Swedish market. To investigate whether the market power of firms in the food and beverage industry has been reduced by increased European competition, the sample is divided into four sub-periods: 1990–1993, 1994–1996, 1997–1999, and 2000–2002. The estimates are conducted using time periods of three years to increase the number of observations in each period, compared to defining each year as a period. Moreover, as mentioned, adjustment to the new market conditions may not have been immediate after the Swedish EU accession in 1995, but rather gradual and some adoption may have started in 1994 in anticipation of EU membership. Therefore, the years around 1995 are grouped together. Dummy variables for the periods p are interacted with the mark-up to illustrate the evolution of

average industry mark-up over time. For estimation purposes the first time period is excluded, so that the estimates indicate the deviation from the first time period. More formally we estimate:

$$\Delta Y_{it} = \mu \Delta X_{it} + \beta_p \sum_{p=2}^{p=4} \Delta X_{it} * D_p + \varepsilon_{it} \quad (3.2)$$

$$\varepsilon_{it} = \alpha_i + \lambda_t + u_{it}$$

where D_p are the period dummy variables, that is, the estimated β_p coefficients will indicate the deviation from the first period (1990–1993) and μ will indicate the mark-up in the first period.

Table 4 Dynamics of the mark-up in the food and beverage industry

Period/sample	all	emp>49
Mark-up (1990-1993)	1.096***	1.090***
	[0.012]	[0.014]
1994-1996	-0.160*	-0.100
	[0.088]	[0.089]
1997-1999	0.032	-0.014
	[0.023]	[0.023]
2000-2002	0.015	0.015
	[0.029]	[0.026]
Firm effects	Yes	Yes
Time effects	Yes	Yes
Observations	3680	1550
Number of firms	530	238

Robust standard errors are within brackets. * Significant at 10 %, ** Significant at 5 %, *** significant at 1 %.

Table 4 shows that the average mark-ups in the food and beverage industry were not affected by Swedish EU-membership. There was a temporary decrease in the mark-up in the period around 1995, but thereafter the mark-up rose again. The reduction in the mark-up around 1995 may indicate an adjustment to meet potential competition from EU producers, since the threat of entry of new firms into the market constrained incumbent firms' pricing policy. In the following periods (1996–2002) competition may not have been as fierce as expected. It could also be the case that firms adjusted to the initial price reduction by improving productivity. The result indicates the average for all sectors and does not differentiate between sectors that were protected before 1995 and those that were not. This type of aggregated analysis may fail to capture important changes in the pricing behaviour of firms. The average

mark-up of the industry may remain unchanged while mark-ups increased in some sectors and decreased in others. Furthermore, firms in the food and beverage industry do not compete in the same market; hence the analysis should be conducted on a more disaggregated level. Due to the limited number of observations the analysis is conducted using 3-digit NACE sectors.

In order to accommodate variations across sectors and between the periods before and after 1995, equation (3.4) is reformulated to

$$\Delta Y_{ijt} = \beta_{pj} \sum_{k=1}^{k=2} \sum_{J=1}^{J=9} \Delta X_{it} * D_p * D_j + \beta_{pF} \sum_{p=1}^{p=2} \Delta X_{ijt} * D_F * D_p + \varepsilon_{ijt} \quad (3.3)$$

$$\varepsilon_{ijt} = \alpha_i + \lambda_t + u_{ijt}$$

The coefficient of β_{1j} indicates the average mark-up in sector *j* in the first period and β_{2j} captures the change in average firm mark-up in sector *j* from period 1 (1990–1994) to period 2 (1995–2002).

The estimation results in Table 5 indicate that the changes in mark-ups are qualitatively the same in both samples (with and without small firms) and that the changes in sector mark-ups vary across sectors. Note that asterisks in columns 1 and 3 of the table indicate a significant difference from one. The average mark-up in two sectors (Dairy, and Vegetable & animal oils) increases significantly, while it decreased in two other sectors (Fruit and vegetables, and Animal feeds). Both sectors showing increasing mark-ups have relatively low mark-ups in the first period, and the Fruit & vegetable sector has the highest mark-up in the first period. In the meat preparation sector the small firms' mark-up tends to decrease while the larger firms' mark-up does not. In the second period the sectors mark-up is not significantly above 1 (all firms), indicating a competitive market, but it is significantly above one for the larger firms (more than 49 employees) in the same period.

Table 5 Dynamics of Mark-up by sector

Sample	all		emp>49		Classification
Sector/period	1990-1994	1995-2002	1990-1994	1995-2002	EFTA (Alternative)
Meat preparation	1.064***	-0.063	1.062***	0.003	S (S)
	[0.008]	[0.059]	[0.010]	[0.016]	
Fish processing	1.066	0.046	1.273	-0.143	S (NS)
	[0.041]	[0.042]	[0.216]	[0.219]	
Fruit & Vegetables	1.174***	-0.240**	1.157***	-0.296***	NS (S)
	[0.052]	[0.096]	[0.042]	[0.096]	
Vegetable & animal oils	1.050***	0.096**	1.078***	0.083**	NS (S)
	[0.014]	[0.041]	[0.015]	[0.039]	
Dairy products	1.042	0.106*	1.030	0.118*	S (PS)
	[0.048]	[0.058]	[0.052]	[0.067]	
Grain milling	1.076	-0.016	1.237*	-0.121	NS (S)
	[0.101]	[0.108]	[0.135]	[0.139]	
Animal feeds	1.067***	-0.051*	1.062***	-0.046*	S (S)
	[0.023]	[0.026]	[0.022]	[0.024]	
Other food products	1.110***	0.047	1.115***	0.022	PS (PS)
	[0.040]	[0.048]	[0.035]	[0.049]	
Beverages	1.080**	0.007	1.090**	-0.007	PS (PS)
	[0.033]	[0.039]	[0.040]	[0.084]	
Foreign owned	0.052	0.036	0.095***	-0.006	
	[0.039]	[0.046]	[0.037]	[0.045]	
Firm effects	Yes	Yes	Yes	Yes	
Time effects	Yes	Yes	Yes	Yes	
Observations	3680	3680	1550	1550	

Notes: S = sensitive sector, NS = non-sensitive, PS = partially sensitive. Robust standard errors are within brackets. * Significant at 10 %, ** Significant at 5 %, *** significant at 1 %. Asterisks in columns 1 and 3 indicate a significant deviation from 1.

Competition and barriers to trade

The results above clearly illustrate significant variations across sectors and over time within the food and beverage industry. To analysis whether these changes are the result of reduced barriers to trade, the evolution of mark-ups in sectors that were protected before 1995 is compared to that of sectors that were not protected. A reduction in barriers to trade and increased competitive pressure are expected to reduce the relative mark-up in sensitive sectors. Two dummy variables are introduced to test this assumption. The first is equal to one for firms in *sensitive* sectors and the second is equal to one for firms in non-sensitive sectors. These dummy variables are interacted with the mark-up and two period dummy variables, pre-1995 (1990-1994) and post-1995 (1995–2002). That is, we estimate:

(3.4)
$$\Delta Y_{it} = \beta_{pF} \sum_{p=1}^{p=2} \Delta X_{it} * D_F * D_p + \beta_{ps} \sum_{s=1}^{s=2} \sum_{p=1}^{p=2} \Delta X_{it} * D_p * D_s + \varepsilon_{it}$$
$$\varepsilon_{it} = \alpha_i + \lambda_t + u_{it}$$

where D_F is a dummy variable equal to one if the firm is foreign owned, D_p the two period dummy variables and D_s the two sensitive and non-sensitive sector dummy variables described above. The estimated coefficients of the dummy variables indicate the average mark-up for a firm in a non-sensitive sector in the two periods, and the difference between firms in sensitive and non-sensitive sectors in the two periods. The construction of the dummy variables implies that the difference between firms in non-sensitive and sensitive sectors can be interpreted directly from the estimated coefficients. In addition, the issue of the absolute evolution of the mark-up in sensitive sectors is tested by means of a standard Wald test.[11]

Table 6 Dynamics of mark-up in non-sensitive and sensitive sectors

Definition of sensitive sectors	EFTA		Alternative Swedish	
Firms included	All	emp>49	All	emp>49
Mark-up period 1	1.109***	1.107***	1.095***	1.102***
	[0.034]	[0.025]	[0.030]	[0.028]
Sensitive sector mark-up period 1	-0.045	-0.039	-0.026	-0.031
	[0.034]	[0.026]	[0.030]	[0.029]
Mark-up period 2	1.130***	1.015***	1.151***	1.152***
	[0.033]	[0.084]	[0.023]	[0.028]
Sensitive sector mark-up period 2	-0.090*	0.042	-0.149***	-0.159***
	[0.048]	[0.081]	[0.047]	[0.060]
Foreign owner period 1	0.060**	0.106***	0.057*	0.104***
	[0.031]	[0.032]	[0.032]	[0.032]
Foreign owner period 2	0.028	0.081	0.053	-0.001
	[0.043]	[0.067]	[0.046]	[0.045]
F test: Sensitive sectors' mark-ups equal in both periods	0.42	0.36	2.42	1.89
P-value	0.52	0.55	0.12	0.17
Firm effects	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
Observations	3680	1550	3680	1550

Robust standard errors are within brackets. * Significant at 10 %, ** Significant at 5 %, *** significant at 1 %. A list of sectors classified as sensitive is included in the appendix.

[11] The regressions have also been estimated controlling for cooperative ownership and export status of the firms, but since the coefficients are insignificant in all specifications they are not included in the specification.

The results in Table 6 show that mark-ups in sensitive and non-sensitive sectors do not differ significantly in the period prior to 1995; hence it seems like firms in protected sectors have not been able to increase their mark-ups despite being sheltered from import competition. This conclusion might, however, be erroneous since other factors such as entry costs, concentration and the presence of foreign-owned firms and/or cooperatives vary across sectors. Besides, the production costs of firms in protected sectors may be relatively high as a result of inefficient production methods, and thus the price-cost margin may be low even though prices are relatively high.

The results of the estimation, using the EFTA-classification of sensitive sectors (EFTA 1992), shown in the first columns of Table 6 are inconclusive. The relative average mark-ups of firms in sensitive, compared to non-sensitive, sectors is diminishing indicating increased competition. When small firms are excluded from the sample, the relative average mark-up of sensitive sectors are not affected by the reduction in barriers to trade, suggesting that large firms have been able to adjust to the new situation without reducing their mark-up. Re-estimating the model with the Swedish definition of sensitive sectors, the last two columns of Table 6 reveal conclusive evidence of a reduction in the relative average mark-ups of sensitive sectors. The absolute mark-up of sensitive sectors shows a weak tendency to decrease as well, as indicated by the Wald test at the bottom of table 6. That is, the reduction in barriers to trade have had a disciplinary effect on the mark-ups of sectors identified as sensitive, and hence previously sheltered from import competition. The differences in the results of the two classifications indicate that the elimination of tariffs has had an important effect on competition and that the effect of NTBs has been less important. Foreign-owned firms have higher mark-ups than domestic firms in the pre-1995 period but not after 1995. A reduction in foreign firms' mark-ups would be expected if entry costs were reduced since less productive foreign firms would find entry profitable. That is, the reduction in foreign firms' mark-ups indicates a reduction of entry costs for foreign firms, which contributes to increased competition in the Swedish food and beverage industry.

4 Summary and conclusions

This study estimates the market power of firms in the Swedish food and beverage industry in the period 1990–2002. The results are used to analyse the effect of increased European competition on market power and prices. Prior to Swedish membership in the EU in 1995 the food and beverage industry was protected from import competition by both tariff and non-tariff barriers to trade, and the reduction of these barriers was expected to increase competition and reduce the high Swedish food prices.

The results in this paper show that the average mark-up of most sectors in the food and beverage industry is above one, indicating that firms have some degree of market power. The variations across sectors are large, which contributes to explaining part of the variations in the price differences, across products, between Sweden and other EU countries.

The average mark-up of the food and beverage industry did not decrease between 1990 and 2002. This does not necessarily imply that there were no benefits from reducing barriers to trade. Firms could have adjusted to more intense competition by improving efficiency. However, this does not seem to be the case in the Swedish food and beverage industry in general. Gullstrand and Jörgensen (2005) find that productivity in the industry in general has not increased. Another possible explanation for the lack of changes at industry level is that resources have been reallocated within the industry. Indeed, the evolution of market power shows significant differences across sectors. In some sectors firms' market power increases while it decreases in others. The largest reduction of market power is found in the fruit and vegetables sector while market power increases in the dairy sector.

The market power, of firms with a high initial degree of protection (tariffs or non-tariff barriers) has decreased and so has the entry cost of foreign firms into the Swedish market. That is, the reduction in trade cost has affected competition and prices in sectors insulated from competition before 1995.

References

Badinger, H. (2004): "Do We Really Know That the EU's Single Market Programme Has Fostered Competition? Testing for a Decrease in Markup Ratios in EU Industries," Working Paper, 55, Europainstitut.

Boone, J., R. Griffith and R. Harrison (2005): "Measuring Competition," *AIM Research Working Paper*, 22.

Bottasso, A. and A. Sembenelli (2001): "Market Power, Productivity and the EU Single Market Program: Evidence from a Panel of Italian Firms," *European Economic Review*, 45(1), 167-186.

EFTA (1992): "Effects of "1992" on Manufacturing Industries of the EFTA Countries," *EFTA Occasional Paper*, 38.

Eurostat (1996): "NACE Rev. 1. Statistical Classification of Economic Activities in the European Community," forum.europa.eu.int/irc/dsis/bmethods/info/data/new/classifications/nace_en.pdf (11-06-2006).

Gullstrand, J. and H. Johansson (2005): "The Disciplinary Effect of the Single Market on Swedish Firms," *Open Economies Review*, 16, 381-398.

------ and C. Jörgensen (2005): "Deeper Integration and Productivity: The Swedish Food and Beverage Industry," Unpublished manuscript, Lund, Sweden: Lund University, Department of Economics (www.test.se).

Hall, R. E. (1988): "The Relation Between Price and Marginal Cost in U.S. Industry," *Journal of Political Economy*, 96(5), 921-947.

Hammarlund, C. (2005): "Konkurrenskraft På Fiskeriprodukter – Sverige i Världen," Report, 2005:4, Swedish Institute for Food and Agricultural Economics.

Harrison, A. E. (1994): "Productivity, Imperfect Competition and Trade Reform : Theory and Evidence," *Journal of International Economics*, 36(1-2), 53-73.

Hoekman, B., H. L. Kee and M. Olarrega (2004): "Tariffs, Entry Regulation and Markups: Country Size Matters," *Contributions to Macroeconomics*, 4(1), Article 8.

Krishna, P. and D. Mitra (1998): "Trade Liberalization, Market Discipline and Productivity Growth: New Evidence from India," *Journal of Development Economics*, 56(2), 447-462.

Levinsohn, J. (1993): "Testing the Imports-as-Market-Discipline Hypothesis," *Journal of International Economics*, 35(1-2), 1-22.

Lundin, N. (2004): "Import Competition, Product Differentiation and Mark-Ups: - Microeconomic Evidence from Swedish Manufacturing in the 1990s," *FIEF Working paper*, 195.

Oliveira Martins, J. and S. Scarpetta (1999): "The Levels and Cyclical Behaviour of Mark-Ups Across Countries and Market Structures," *OECD Economics Department Working Paper*, 213(OECD Publishing).

Roeger, W. (1995): "Can Imperfect Competition Explain the Difference Between Primal and Dual Productivity Measures? Estimates for U.S. Manufacturing," *Journal of Political Economy*, 103(2), 316-330.

Sauner-Leroy, J.-B. (2003): "The Impact of the Implementation of the Single Market Programme on Productive Efficiency and on Mark-Ups in the European Union Manufacturing Industry," *European Economy, European Commission Directorate-General for Economic and Financial Affairs, Economic Papers*, 192.

SOU (1997): *En livsmedelsstrategi för Sverige*.,SOU, Stockholm: Nordstedts Tryckeri AB.

Sveriges Livsmedelsindustriförbund, Industriförbundet and Kommerskollegium (1993): *Konsekvenser av ett EG-medlemskap för svensk livsmedelsindustri*, Stockholm: Förlags AB Industrilitteratur.

Tybout, J. R. (1992): "Linking Trade and Productivity: New Research Directions," *World Bank Economic Review*, 6(2), 189-211.
------ (2003): "Plant- and Firm-Level Evidence on "New" Trade Theories," in *Handbook of International Trade*, ed. by K. E. Choi and J. Harrigan, Oxford, UK: Blackwell Publishing, 388-415.
Vancauteren, M. and B. Henry de Frahan (2004): "Harmonization of Food Regulations and Trade in the Single Market: Evidence from Disaggregated Data," *IRES Discussion Paper*, 2004-21.

Appendix

Sensitive sub-sectors in the food and beverage sector

Sensitive sectors have been identified using two methods. The first defines Sensitive 4-digit sectors based on EFTA (1992), as shown in column 3 Table A1. Sectors found to have high non-tariff barriers in the EFTA study are classified as sensitive. The EFTA study uses NACE 1970, which has been converted to NACE rev. 1 using a correspondence table provided by Eurostat (1996). The second method, the Swedish classification introduced in column 4 of Table A1, defines sensitive sectors based on (SOU 1997) and (Sveriges Livsmedelsindustriförbund et al. 1993) These studies identify sectors (mostly 3-digit) that were protected by tariffs prior to 1995. Sectors that are mentioned as protected, by at least one of the studies, are classified as sensitive in this paper.

Table A1 Classifications of sensitive sectors

NACE rev. 1	Sector description	EFTA	Alternative	# obs
1511	Production and preserving of meat	S	S	382
1512	Production and preserving of poultry meat	S	S	89
1513	Production of meat and poultry meat products	S	S	670
1520	Processing and preserving of fish and fish products	S	NS	297
1531	Processing and preserving of potatoes	NS	S	80
1532	Manufacture of fruit and vegetable juice	NS	S	41
1533	Processing and preserving of fruit and vegetables n.e.c.	NS	S	119
1541	Manufacture of crude oils and fats	NS	S	17
1542	Manufacture of refined oils and fats	NS	S	12
1543	Manufacture of margarine and similar edible fats	NS	S	28
1551	Operation of dairies and cheese making	S	S	125
1552	Manufacture of ice cream	S	NS	74
1561	Manufacture of grain mill products	NS	S	138

NACE rev. 1	Sector description	EFTA	Alternative	# obs
1562	Manufacture of starches and starch products	NS	S	61
1571	Manufacture of prepared feeds for farm animals	S	S	49
1572	Manufacture of prepared pet foods	S	S	18
1581	Manufacture of bread; manufacture of fresh pastry goods & cakes	NS	NS	1172
1582	Manufacture of rusks & biscuits; manufacture of preserved pastry goods & cakes	NS	NS	194
1583	Manufacture of sugar	S	S	13
1584	Manufacture of cocoa; chocolate and sugar confectionery	S	S	218
1585	Manufacture of macaroni, noodles, couscous and similar farinaceous products	NS	NS	3
1586	Processing of tea and coffee	NS	NS	63
1587	Manufacture of condiments and seasonings	NS	NS	70
1588	Manufacture of homogenized food preparations & dietetic food	NS	NS	14
1589	Manufacture of other food products n.e.c.	NS	NS	112
1591	Manufacture of distilled potable alcoholic beverages	NS	NS	21
1592	Production of ethyl alcohol from fermented materials	NS	NS	8
1594	Manufacture of cider and other fruit wines	NS	NS	13
1596	Manufacture of beer	S	S	79
1597	Manufacture of malt	S	S	13
1598	Production of mineral waters and soft drinks	NS	NS	75

Notes S = sensitive, NS = not sensitive. Source EFTA (1992) Table 7, converted to NACE rev. 1 and Sveriges Livsmedesindustriförbund et al. (1993)

Mathematical appendix

First, to derive the Solow residual, note that logarithmic differentiation of the production function (2.1) gives

(5.1) $$\Delta q_{it} = \varepsilon^{Q}_{Nit}\Delta n_{it} + \varepsilon^{Q}_{Mit}\Delta m_{it} + \varepsilon^{Q}_{Kit}\Delta k_{it} + \Delta\theta_{it}$$

The derivatives are replaced by yearly changes so that

$$\Delta x_j = \ln x_{it} - \ln x_{it-1} = \frac{x_{it} - x_{it-1}}{x_{it}} = \frac{\Delta x_{it}}{x_{it}}, \text{ for } x = n, m, k, \theta$$

Under constant returns to scale the elasticities of the inputs with respect to output will sum to one:

(5.2) $$\varepsilon^{Q}_{Nit} + \varepsilon^{Q}_{Mit} + \varepsilon^{Q}_{Kit} = 1$$

Hence equation (5.1) can be written as

(5.1)´ $$\Delta q_{it} = \varepsilon^{Q}_{Nit}\Delta n_{it} + \varepsilon^{Q}_{Mit}\Delta m_{it} + \left(1 - \varepsilon^{Q}_{Nit} - \varepsilon^{Q}_{Mit}\right)\Delta k_{it} + \Delta\theta_{it}$$

Assuming perfect competition on input markets but imperfect competition on output markets and that labour and materials are flexible, profit maximisation implies that

(5.3) $$\varepsilon_{Jit}^{Q} = \mu_{it}\alpha_{Jit}, \text{ for } J = N, M$$

where $\alpha_{Jit} = \frac{P_{Jt}J_{it}}{P_{it}Q_{it}}$ for $J = N, M$ and $\mu_{it} = \frac{P_{it}}{MC_{it}}$ is the price mark-up above marginal costs. To show this note that firms profit maximisation implies that marginal revenue of labour equals the wage paid to labour and that marginal cost equals marginal revenue. That is,

(5.4) $$\frac{\partial R}{\partial N} = \frac{\partial R}{\partial Q}\frac{\partial Q}{\partial N} = P_N, \; MC_{it} = \frac{\partial R}{\partial Q}$$

Further, define the elasticity of output with respect to labour ε_L^Q, labour costs' share of sales α_{Lit} and the mark-up μ:

(5.5) $$\varepsilon_N^Q = \frac{\partial Q}{\partial N}\frac{N}{Q}, \alpha_{Nit} = \frac{P_{Nt}N_{it}}{P_{it}Q_{it}}, \; \mu = \frac{\mathrm{P_{it}}}{\mathrm{MC_{it}}}$$

From the second equation above it follows that $N_{it} = \frac{\alpha_{Nit}P_{it}Q_{it}}{P_{Nt}}$. Substituting this into the first equation and using the profit maximisation conditions from (5.4) and finally the third definition in (5.5), we show that equation (5.3) follows from the profit maximisation behaviour of firms. Along the same lines of reasoning, the condition for materials also follows from the profit maximisation of firms.

(5.6) $$\varepsilon_L^Q = \frac{\partial Q}{\partial N}\frac{\alpha_{Nit}P_{it}}{P_{Nt}} = \frac{\partial Q}{\partial N}\frac{\alpha_{Nit}P_{it}}{\frac{\partial R}{\partial Q}\frac{\partial Q}{\partial N}} = \frac{\alpha_{Nit}P_{it}}{\frac{\partial R}{\partial Q}} = \alpha_{Nit}\frac{P_{it}}{MC} = \alpha_{Nit}\mu_{it}$$

Now equation (5.3) can be utilised to rewrite equation (5.1)´

$$\Delta q_{it} = \mu_{it}\alpha_{Nit}\Delta n_{it} + \mu_{it}\alpha_{Mit}\Delta m_{it} + \left(1 - \mu_{it}\alpha_{Nit} - \mu_{it}\alpha_{Mit}\right)\Delta k_{it} + \Delta\theta_{it}$$

$$\frac{\Delta q_{it}}{\mu_{it}} = \alpha_{Nit}\Delta n_{it} + \alpha_{Mit}\Delta m_{it} + \frac{\Delta k_{it}}{\mu_{it}} - \Delta k_{it} + \left(1 - \alpha_{Nit} - \alpha_{Mit}\right)\Delta k_{it} + \frac{\Delta\theta_{it}}{\mu_{it}}$$

(5.7) $$\frac{\Delta q_{it}}{\mu_{it}} + \Delta q_{it} - \Delta q_{it} = \alpha_{Nit}\Delta n_{it} + \alpha_{Mit}\Delta m_{it} + \frac{\Delta k_{it}}{\mu_{it}} - \Delta k_{it} + \left(1 - \alpha_{Nit} - \alpha_{Mit}\right)\Delta k_{it} + \frac{\Delta\theta_{it}}{\mu_{it}}$$

$$\Delta q_{it} - \beta_{it}\Delta q_{it} = \alpha_{Nit}\Delta n_{it} + \alpha_{Mit}\Delta m_{it} - \beta_{it}\Delta k_{it} + \left(1 - \alpha_{Nit} - \alpha_{Mit}\right)\Delta k_{it} + \left(1 - \beta_{it}\right)\Delta\theta_{it}$$

$$\Delta q_{it} - \alpha_{Nit}\Delta n_{it} - \alpha_{Mit}\Delta m_{it} - \left(1 - \alpha_{Nit} - \alpha_{Mit}\right)\Delta k_{it} = \beta_{it}\left(\Delta q_{it} - \Delta k_{it}\right) + \left(1 - \beta_{it}\right)\Delta\theta_{it}$$

Where the last expression is exactly the Solow residual, equation (2.2), in the main text of the paper. The dual Solow residual can be derived in a similar fashion. For a detailed discussion see, for example Lundin (2004).

To derive equation (2.4), we proceed in two steps to simplify the exposition. First, subtract the left-hand side of equation (2.3) from the left-hand side of equation (2.2)

$$\beta_{it}\left(\frac{\Delta Q_{it}}{Q_{it}}-\frac{\Delta K_{it}}{K_{it}}\right)+\left(1-\beta_{it}\right)\frac{\Delta\Theta_{it}}{\Theta_{it}}+\beta_{it}\left(\frac{\Delta R_{it}}{R_{it}}-\frac{\Delta P_{it}}{P_{it}}\right)-\left(1-\beta_{it}\right)\frac{\Delta\Theta_{it}}{\Theta_{it}} \tag{5.8}$$

$$\beta_{it}\left(\frac{\Delta Q_{it}}{Q_{it}}-\frac{\Delta K_{it}}{K_{it}}\right)+\beta_{it}\left(\frac{\Delta P_{it}}{P_{it}}-\frac{\Delta R_{it}}{R_{it}}\right)=\beta_{it}\left[\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]$$

Then repeat this with the right-hand side of the equations.

$$\frac{\Delta Q_{it}}{Q_{it}}-\alpha_{Nit}\frac{\Delta N_{it}}{N_{it}}-\alpha_{Mit}\frac{\Delta M_{it}}{M_{it}}-\left(1-\alpha_{Nit}-\alpha_{Mit}\right)\frac{\Delta K_{it}}{K_{it}}-\left(\alpha_{Nit}\frac{\Delta P_{Nt}}{P_{Nt}}+\alpha_{Mit}\frac{\Delta P_{Mit}}{P_{Mit}}+\left(1-\alpha_{Nit}-\alpha_{Mit}\right)\frac{\Delta R_{it}}{R_{it}}-\frac{\Delta P_{it}}{P_{it}}\right)= \tag{5.9}$$

$$\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}-\alpha_{Nit}\left(\frac{\Delta N_{it}}{N_{it}}+\frac{\Delta P_{Nt}}{P_{Nt}}\right)-\alpha_{Mit}\left(\frac{\Delta M_{it}}{M_{it}}+\frac{\Delta P_{Mit}}{P_{Mit}}\right)-\left(1-\alpha_{Nit}-\alpha_{Mit}\right)\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)$$

Finally, combining these results gives equation (2.4) in the main text.

To arrive at equation (2.5), the relation between the Lerner index and the mark-up, $\beta_{it}=1-\frac{1}{\mu_{it}}$ is used

$$\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\alpha_{Nit}\left(\frac{\Delta N_{it}}{N_{it}}+\frac{\Delta P_{Nit}}{P_{Nit}}\right)-\alpha_{Mit}\left(\frac{\Delta M_{it}}{M_{it}}+\frac{\Delta P_{Mit}}{P_{Mit}}\right)-\left(1-\alpha_{Nit}-\alpha_{Mit}\right)\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)=$$

$$\beta_{it}\left[\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]\Leftrightarrow$$

$$\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\alpha_{Nit}\left[\left(\frac{\Delta N_{it}}{N_{it}}+\frac{\Delta P_{Nit}}{P_{Nit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]-\alpha_{Mit}\left[\left(\frac{\Delta M_{it}}{M_{it}}+\frac{\Delta P_{Mit}}{P_{Mit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right] \tag{5.10}$$

$$-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)=\left(1-\frac{1}{\mu_{it}}\right)\left[\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]\Leftrightarrow$$

$$-\alpha_{Nit}\left[\left(\frac{\Delta N_{it}}{N_{it}}+\frac{\Delta P_{Nit}}{P_{Nit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]-\alpha_{Mit}\left[\left(\frac{\Delta M_{it}}{M_{it}}+\frac{\Delta P_{Mit}}{P_{Mit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]=$$

$$\left(-\frac{1}{\mu_{it}}\right)\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)+\frac{1}{\mu_{it}}\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)$$

Finally, multiplying by μ_{it} and rearranging the terms gives

$$\left(\frac{\Delta Q_{it}}{Q_{it}}+\frac{\Delta P_{it}}{P_{it}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)=$$

$$\mu_{it}\left[\alpha_{Nit}\left[\left(\frac{\Delta N_{it}}{N_{it}}+\frac{\Delta P_{Nit}}{P_{Nit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]+\alpha_{Mit}\left[\left(\frac{\Delta M_{it}}{M_{it}}+\frac{\Delta P_{Mit}}{P_{Mit}}\right)-\left(\frac{\Delta K_{it}}{K_{it}}+\frac{\Delta R_{it}}{R_{it}}\right)\right]\right] \tag{5.11}$$

which is equation (2.5) in the main text.