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Import Competition, Product Differentiation and Mark-Ups

- Microeconomic evidence from Swedish manufacturing in the 1990s*

by

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Abstract

This paper examines how import competition from different origins and the presence of product differentiation affect market power of Swedish manufacturing firms during the 1990s. Applying Roeger's method (1995), I perform the empirical analysis based on detailed firm-level data and estimate an average mark-up level of Swedish manufacturing firms.

The general finding is that imports from both European countries and other high-income countries outside Europe impose disciplinary effects on price-cost margin of Swedish manufacturing firms. The strongest effect is from the recent EU member countries. However, the competitive pressure associated with import is relaxed in the presence of product differentiation.

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1. Introduction

The link between international trade and market power has been extensively investigated in a large body of empirical work. Import competition on the domestic market has been seen as a disciplinary device to constrain market power of domestic firms, and numerous studies have provided evidence of a disciplinary effect imposed by import competition.[1]

For a small open economy, like Sweden, the impact of import competition is highly relevant for the development of manufacturing sectors. Furthermore, important institutional changes have taken place in the 1990s, namely the launch of the EU's internal market in 1992 and Sweden's EU membership in 1995.

When the link between international trade and market power is examined, the Lerner index is the most commonly used measure for monopolistic power. The Lerner index is defined as $(p - m)/p$, where p is price and m is marginal cost. Since the marginal cost is not observable, an average price-cost margin (PCM) approach that uses average cost instead of marginal cost is frequently applied.[2] However, the average price-cost approach suffers in general from endogeneity bias due to the simultaneity among input, output, profitability and productivity. Furthermore, the validity of the average cost PCM measure is challenged because of the instable time-series relationship between accounting profit and PCM due to measurement errors in fixed costs.[3] With an alternative methodology, developed by Roeger (1995), it is feasible to estimate marginal cost mark-ups consistently by using OLS.[4]

In this paper I apply Roeger's method to estimate mark-ups to assess the market power of Swedish manufacturing firms in the 1990s using firm-level data. I compare my estimates with former mark-up estimates on Swedish manufacturing using industry level data, as well as estimates on other small and open economies also using firm-level data.

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[1] For instance, Levinsohn (1993), Harrison (1994), Kattics and Petersen (1994), Krishna and Mitra (1998), Konings and Vandenbusssche (2002), Konings et al. (2001, 2003). Tybout (2001) gives a more detailed survey of the existing empirical literature, in particular on micro-level studies.

[2] The price-cost margin is defined as $PCM = (value\ added - payroll) / value\ added$ .Several studies on Swedish manufacturing, using both industry and firm data, have applied such a measure, e.g. Stålhammar (1991), Hansson (1992) and Lundin (2003).

[3] Bresnahan (1987) argues forcefully on this point.

[4] Recently, the method has been frequently used, e.g. Konings et al. (2001, 2002, 2003) on manufacturing in Belgium, the Netherlands and on a number of transition economies, and Görg and Warzynski (2003) on manufacturing firms in the U.K.

Moreover, I investigate the impact of imports and product differentiation on mark-ups. Bernhofen (2001) argues that when product differentiation is linked to the intensity of import penetration, a high degree of product differentiation encourages firms to increase their supplies to the domestic and the foreign markets. Hence, the volume of intra-industry trade is positively related to the degree of product differentiation.[5] Theoretically, product differentiation thus leads to monopolistic competition and intra-industry trade that may reduce the disciplinary effect imposed by import competition. Since R&D investments are large and the share of intra-industry trade is high in Swedish manufacturing, we would expect to observe a high degree of product differentiation. Nevertheless, this dimension has not been taken into account in previous studies of the disciplinary effect of imports in Swedish manufacturing.

To preview my results, I find that import competition has affected mark-ups in Swedish manufacturing firms during the 1990s. There is a disciplinary effect of import competition from EU countries and high-income countries outside Europe. However, product differentiation appears to relax the competitive pressure of imports.

The plan of the paper is as follows. In section 2, I introduce Roeger's method to estimate price-cost margins and discuss some methodological issues. Section 3 presents the data and gives some descriptive facts on sectoral characteristics and the development of import penetration in Swedish manufacturing in the 1990s. Section 4 contains the empirical specifications and the results, and section 5 concludes.

[5] Bernhofen (2001) also shows that the positive relationship between product differentiation and intra-industry trade is robust to various modes of oligopolistic competition and the assumption of free or restricted entry in an industry.

2. Methodology

Let me first briefly describe and discuss the method developed by Roeger (1995), which I apply to estimate price-cost margins. The method starts out from a standard production function of a firm *i* at time *t*

$$Q_{it} = A_{it} F_i \left(K_{it}, S_{it}, U_{it}, M_{it}\right) \qquad (1)$$

where *Q* is output, *K* is capital, *S* is skilled and *U* is unskilled labour, and *M* is material input. *A* denotes the technological level and I assume Hicks-neutral technical change.

Under the assumption of constant returns to scale, the primal Solow residual *SR* can be expressed as:[6]

$$SR_{it} = \hat{Q}_{it} - (1 - \theta_{iSt} - \theta_{iUt} - \theta_{iMt})\hat{K}_{it} - \theta_{iSt}\hat{S}_{it} - \theta_{iUt}\hat{U}_{it} - \theta_{iMt}\hat{M}_{it} =$$
$$(1 - \beta_{it})\hat{A}_{it} + \beta_{it}\left(\hat{Q}_{it} - \hat{K}_{it}\right) \qquad (2)$$

$\hat{X}$ is relative change in *X*. $\hat{A}_{it}$ is technical change and θ_{Jit} is the share of factor *J* ($J = K, S, U, M$) in total revenue. β_{it} is the Lerner index, which is closely related to the mark-up, $\mu_{it} = p_{it} / m_{it}$, price over marginal cost:

$$\beta_{it} = \frac{p_{it} - m_{it}}{p_{it}} = 1 - \frac{1}{\mu_{it}} \qquad (3)$$

Hence, the primal (quantity) residual is a weighted average of the technical change and the rate of change in capital productivity, and the Lerner index determines the weights.

By using the cost function that corresponds to the production function in Equation (1), we can derive the dual (price-based) Solow residual *SRP*:

$$SRP_{it} = (1 - \theta_{iSt} - \theta_{iUt} - \theta_{iMt})\hat{w}_{iKt} + \theta_{iSt}\hat{w}_{iSt} + \theta_{iUt}\hat{w}_{iUt} + \theta_{iMt}\hat{w}_{iMt} - \hat{p}_{it} =$$
$$(1 - \beta_{it})\hat{A}_{it} - \beta_{it}\left(\hat{p}_{it} - \hat{w}_{iKt}\right) \qquad (4)$$

[6] Appendix 1 presents a detailed derivation of the expression for the primal Solow residual *SR* and for the dual Solow residual *SRP* in Equation (4) below.

$\hat{w}_{iJt}$ and $\hat{p}_{it}$ are the relative changes in the price of factor *J* and the output price. As in Equation (2), the dual (price-based) Solow residual *SRP* is a weighted average of the technical change and the rate of change in output prices minus the rate of change in capital costs. The weights are determined by the Lerner index as well.

The basic idea of Roeger's method is that the difference between the primal and the dual Solow residuals is due to imperfect competition in the product market. Subtracting SRP_{it} from SR_{it} yields:

$$
\begin{aligned}
&(\hat{Q}_{it} + \hat{p}_{it}) - (1 - \theta_{iSt} - \theta_{iUt} - \theta_{iMt})(\hat{K}_{it} + \hat{w}_{iKt}) - \theta_{iSt}(\hat{S}_{it} + \hat{w}_{iSt}) - \\
&\theta_{iUt}(\hat{U}_{it} + \hat{w}_{iUt}) - \theta_{iMt}(\hat{M}_{it} + \hat{w}_{iMt}) \\
&= \beta_{it}\left[(\hat{Q}_{it} + \hat{p}_{it}) - (\hat{K}_{it} + \hat{w}_{iKt})\right] \qquad (5)
\end{aligned}
$$

By letting ΔY_{it} denote the expression on the left hand side, ΔX_{it} the expression within the brackets on the right hand side, and adding an error term ε_{it}, we obtain:

$$\Delta Y_{it} = \beta_{it} \Delta X_{it} + \varepsilon_{it} \qquad (6)$$

This is the baseline model that I estimate in the coming empirical analysis. The most appealing feature of this methodology is its simplicity. When the productivity (technical change) term is cancelled out, as shown above in Equation (5), price-cost margins can be estimated consistently by using OLS. Furthermore, this method requires only nominal variables, and thus it helps to overcome measurement errors owing to lack of detailed price data. Despite these advantageous features associated with Roeger's methodology, there are some critical theoretical and empirical issues that need to be discussed before moving on to the estimations.

Theoretically, Roeger's methodology relies on the assumption of constant returns to scale. This restrictive assumption leads, as shown by Basu and Fernald (1997), to upward (downward) bias in the mark-up estimation depending on decreasing (increasing) returns to scale. Notwithstanding, the potential bias that may emerge in the presence of non-constant returns to scale I have still chosen to stick to Roeger's straightforward method to estimate mark-ups.

Empirical estimates of returns to scale are somewhat mixed. Haskel et al. (1995) and Linnemann (1999) find constant returns to scale in UK and

German manufacturing. The result in Basu and Fernald (1997) using US manufacturing data indicates that firm-level returns to scale are constant or slightly decreasing, while Klette (1999), which analyses Norwegian manufacturing, implies decreasing returns to scale. Also Kee (2002), which relaxes both the assumptions of constant returns to scale and perfect competition in a study of Singapore's manufacturing, finds evidence of decreasing returns to scale, as well as of market power.

The non-zero error term in Equation (6) may cause problems for consistent estimation. The error term is supposed to be zero given that the productivity term is cancelled out in the derivation. However, as discussed in Roeger (1995) and in other empirical applications of his method, e.g. Konings et al. (2002) and Görg and Warzynski (2003), measurement errors in production factors are potential sources for a non-zero term.

Measurement errors in capital stocks K_{it} are of particular concern. The book values of capital stock in the balance sheets of enterprise are used in the estimations and I employ firm-specific depreciation rates to construct the firm-specific rental prices of capital w_{iKt}.[7] To assess potential measurement errors in the book-value capital stocks, I have computed an alternative capital stock measure by applying a perpetual inventory method.[8] The correlation between this alternative capital stock measure and the book-value capital stock is high (0.82), which indicates that these measures are very similar. One drawback with the perpetual inventory method is that it suffers more from the missing value problem; as soon as data on net investment is lacking the accumulation is stopped. Since these two measures are so similar, I prefer to use the book values of capital stock in the mark-up estimations because then I get a larger dataset.[9]

Another potential source of measurement errors is the labour input. The labour input used in this study is the number of skilled and unskilled employees at the firm level and not hours worked by different skill categories. Yet, according to Konings et al. (2003), this measurement error does not cause problems for the estimation since the labour input appears only on the left hand side of Equation (6). On the other hand, the inflexibility of the labour market in response to demand shifts in the product market results in labour hoarding that may cause more concern.

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[7] Appendix 2 shows how the rental price of capital has been constructed.

[8] Hansson and Lundin (2003) contains a description of the generation of this capital stock.

[9] The difference in the number of observations by using these two capital stock measures is 776. Yet, I have estimated all the models in the following sections by using both types of capital stocks and they yield very similar results.

This might be particularly valid in the highly centralised and unionised labour market in Sweden. As in earlier empirical applications, I include year dummy variables to control for such demand effects.

3. Data and variables

The data are from Statistics Sweden and have been complied into a microeconomic database at Trade Union Institute for Economic Research (FIEF). From the annual financial reports of the enterprise, data on sales, capital stocks, wage bills and costs of material are obtained. Using data from the register-based labour market statistics (RAMS), I am able to divide firm-level wage bills into wage bills of skilled and unskilled labour.[10] The dataset consists of all manufacturing firms larger than 50 employees for the period 1990-1999.[11] This leaves me with a panel of 3197 unique firms belonging to 93 manufacturing industries at the 3-digit level of the SNI92 classification.[12] The firm-specific rental price of capital has to be derived and I present detailed information on the construction of this variable in Appendix 2.

One might expect that the impact of imports on the mark-ups will vary depending on the country of origin. For instance, the integration among the former 15 EU members has, due to similarities in income and factor endowments, resulted mainly in intra-industry trade, driven by product differentiation and economies of scale, and intra-firm trade, owing to the increasing importance of multinational enterprises. Hence, it is reasonable to presume less competitive impact of imports originating from these countries than of imports from more dissimilar countries (Jacquemin and Sapir 1991). Of particular interest for the future European integration is the effect of imports from the 10 recent EU members. Hansson (1992) found quite a large disciplinary impact of imports from Japan and Asian NICs on the market power of domestic Swedish manufacturing firms in the 1980s. Does this pattern remain in the 1990s? These are the reasons, in the regression analysis in Section 4 for allowing for differential disciplinary

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[10] I define skilled labour as employees with a post-secondary education, i.e. with more than 12 years of schooling.

[11] Manufacturing firms with less than 50 employees are excluded because of problems with missing values in export, capital stock and net investment. This might lead to an upward bias in the estimated mark-ups due to the exclusion of small firms.

[12] Table A2.1 in Appendix 2 presents more information on the panel. Actually, I am using the same firm-level panel data as before in Lundin (2003).

effects of imports from the following five country groups: (i) EU 14 former members (excluding Sweden), (ii) EU 10 recent members, (iii) Japan and Asian NICs, (iv) other high-income countries, and (v) other low-income countries.[13]

Import data by industry and trading partners together with data on exports and sales at industry level are employed to construct sectoral import penetration measures at the SNI92 3-digit level, i.e. the import shares from various country groups in consumption. Table 1 shows the trends in the import shares and export ratios (export to shipment ratios).

In Table 1, we observe that Swedish manufacturing is highly exposed to international trade. The "old" EU member countries are the most important trading partners in terms of both imports and exports. Import penetration from Japan and Asian NICs has decreased, while the export ratio of Swedish firms to this group has increased slightly. The largest changes in import penetration and export orientation over the period 1990-1999 have taken place in trade between Sweden and the recent EU member countries. However, the distributions of import penetrations and export ratios among country groups have been relatively stable over time.

Table 1. Import penetration from and export ratios to different country groups, 1990-1999

Country group	**Import penetration 1990**	**Import penetration 1999**	**Export ratio 1990**	**Export ratio 1999**
EU14 members	0.33	0.37	0.34	0.38
EU10 recent members	0.01	0.03	0.01	0.05
Japan and Asian NICs	0.06	0.04	0.02	0.03
Other high-income countries	0.08	0.09	0.16	0.17
Other low-income countries	0.04	0.04	0.05	0.07
All countries	0.51	0.56	0.58	0.70

[13] See table A2.2 in Appendix 2 for the classification into these five country groups.

Table 2. ***Product compositions of imports from different country groups: 1990-1999***

Sector	EU14	EU10	Japan & Asian NICs	Other high-income	Other low-income
15 Food and beverage	0.05	0.07	0.00	0.06	0.09
16 Tobacco	-	-	-	-	-
17 Textiles	0.02	0.05	0.03	0.01	0.10
18 Wearing apparels	0.02	0.10	0.08	0.01	0.18
19 Leather, footwear	0.01	0.01	0.02	0.00	0.05
20 Wood products	0.01	0.06	0.00	0.01	0.02
21 Pulp and paper	0.02	0.01	0.00	0.02	0.01
22 Publishing, print	0.02	0.01	0.00	0.02	0.00
23 Refined petroleum products	0.03	0.06	0.00	0.03	0.07
24 Chemicals and chemical products	0.13	0.06	0.04	0.12	0.06
25 Rubber and plastic products	0.04	0.02	0.03	0.03	0.02
26 Other non-metallic mineral products	0.02	0.03	0.01	0.02	0.02
27 Basic metals	0.08	0.09	0.01	0.07	0.08
28 Fabricated metal products	0.03	0.04	0.04	0.03	0.02
29 Machinery	0.13	0.08	0.10	0.13	0.04
30 Office machinery and computers	0.05	0.00	0.11	0.07	0.01
31 Electrical machinery and apparatus	0.06	0.07	0.09	0.06	0.04
32 Radio, Tele. communication equipment	0.07	0.06	0.18	0.07	0.07
33 Medical, precision instruments	0.03	0.01	0.05	0.08	0.01
34 Motor vehicles, trailers	0.13	0.07	0.12	0.05	0.02
35 Other transport equipment	0.02	0.01	0.03	0.09	0.03
36 Furniture, manufacturing n.e.c.	0.02	0.09	0.04	0.02	0.08
Total manufacturing	1.00	1.00	1.00	1.00	1.00

It is also interesting to have a look at the product groups in which these trading partners are competing in Swedish market. To give a picture of the product composition in the imports, I calculate the import shares in various industrial sectors of total manufacturing import from each country group. Not surprisingly, it appears from Table 2 that the former EU member countries and other high-income countries have quite similar import compositions, implying that they compete in the same sectors in Swedish market. However, imports from Japan and Asian NICs are more concentrated to a few sectors, such as machinery, electronics and motor vehicles, which is different from the previous two groups. For imports from the recent EU member countries and other low-income countries in capital-intensive sectors, there might be some quality and/or price differences compared to the imports from the relatively more advanced economies.

A firm's mark-up and the impact of import competition may depend on the degree of product differentiation in the sector in which the firm is active. Therefore, I have divided the industries in manufacturing into high- and low-differentiated sectors. The structure taxonomy is based on R&D intensity.[14] R&D intensity is taken as a proxy for product differentiation and degree of innovation; i.e. the high-differentiated sector consists of R&D intensive industries. Table 3 presents some descriptive statistics of firms in the high- and low-differentiated sectors.

The impression we get from the description in Table 3 is that firms in the high-differentiated sector are larger, more skill-intensive and less capital-intensive compared to firms in the low-differentiated sector. Moreover, the firms in the high-differentiated sector have higher export ratios, but at the same time, they face more intensive import competition. In the other words, there seems to be more intra-industry trade in the high-differentiated sector, which is apparent from Table 3.

Table 3. Characteristics of firms in high- and low-differentiated sectors, 1999

Variables	High-differentiated	Low-differentiated	Difference (t-ratio)
Employment	382	246	136 (3.73)
Capital intensity	264	388	-124 (-5.30)
Skill intensity	0.20	0.13	0.07 (11.70)
Export ratio	0.46	0.30	0.16 (11.12)
Import penetration	0.63	0.34	0.29 (31.14)
Intra-industry trade	0.86	0.45	0.41 (24.43)
Number of firms	731	1088	

[14] Martins et al. (1996) contains a description of this simplified classification device.

4. Empirical specifications and results

The empirical analysis is carried out in three steps. At first I utilize the baseline model in Equation (6) to estimate average mark-ups in Swedish manufacturing. After that I include import penetration variables to evaluate the pro-competitive effect of import as a disciplinary device on market power. Finally, product differentiation is introduced into the model to further investigate the differential effects of import competition under various market structures.

4.1 Mark-up estimations

Based on the discussion in Section 2, I employ the following model to estimate average mark-ups during the 1990s for different sectors *j* at the SNI92 2-digit level as well as for the manufacturing as a whole:

$$\Delta Y_{ijt} = \beta_j \Delta X_{ijt} + \lambda_t Year_t + \varepsilon_{ijt} \quad (7)$$

Year dummy variables $Year_t$ control for unobserved yearly fluctuations. The estimation procedure imposes a constraint that the average price-cost margin is constant over time and over firms *i* within a same industry *j*; and β_j is a fixed parameter. Various econometric techniques are used and Table 4 reports the results.

The estimates of average price-cost margins are robust to different estimators. On average, the mark-up in Swedish manufacturing as a whole is above 30 percent (β = 0.23). However, there are significant variations across different sectors within the manufacturing. We observe relatively high mark-ups (over 40 percent) in industrial sectors such as radio, TV and communication equipment, publishing and print, refined petroleum products, chemicals and chemical products (where pharmaceuticals are included), and professional instruments. On the other hand, the mark-ups are relatively low (below 20 percent) in leather and footwear, office machinery and computers, and furniture and manufacturing not elsewhere classified.

An interesting comparison to make is to look at some earlier studies that applied the same methodology. Two such studies are used as benchmarks. The first is by Martins et al. (1996), which is based on industry-level data for Sweden. The second is Konings et. al. (2001) that estimates mark-ups

Table 4. Baseline mark-up estimations

Sector	OLS		Fixed-effect		Random-effect		Hausman test p-value	Number of obs
	Lerner index β_j	**PCM** μ_j	**Lerner index** β_j	**PCM** μ_j	**Lerner index** β_j	**PCM** μ_j		
15-36 All manufacturing	0.23 [14.75]	1.30	0.23 (47.09)	1.31	0.23 (53.03)	1.30	0.56	13220
15 Food and beverage	0.24 [13.64]	1.31	0.24 (13.54)	1.31	0.24 (15.33)	1.31	1.00	1057
16 Tobacco	-	-	-	-	-	-	-	22
17 Textiles	0.19 [6.50]	1.23	0.16 (6.44)	1.20	0.17 (7.14)	1.21	1.00	287
18 Wearing apparels	0.21 [2.02]	1.27	0.14 (1.31)	1.16	0.18 (2.10)	1.22	0.99	101
19 Leather, footwear	0.12 [0.63]	1.13	-	-	-	-	-	21
20 Wood products	0.19 [13.04]	1.24	0.20 (15.80)	1.24	-	-	-	1007
21 Pulp and paper	0.25 [6.67]	1.34	0.25 (15.54)	1.33	0.25 (16.31)	1.34	0.01	612
22 Publishing, print	0.31 [13.13]	1.45	0.31 (16.15)	1.45	0.31 (17.95)	1.45	0.89	1307
23 Refined petroleum	0.44 [3.58]	1.78	0.44 (3.93)	1.78	-	-	-	45
24 Chemicals & chemical	0.34 [7.56]	1.51	0.36 (19.93)	1.55	-	-	-	659
25 Rubber and plastic	0.19 [4.23]	1.24	0.21 (8.35)	1.26	0.19 (8.89)	1.24	0.81	640

Table 4. (continued)

26 Other non-metallic mineral	0.25 [8.57]	1.33	0.24 (10.18)	1.32	-	-	-	501
27 Basic metals	0.18 [9.79]	1.22	0.20 (9.41)	1.24	-	-	-	496
28 Fabricated metal products	0.23 [14.16]	1.30	0.25 (14.87)	1.34	-	-		1397
29 Machinery	0.19 [9.45]	1.23	0.19 (17.08)	1.24	0.19 (18.60)	1.23	0.01	2104
30 Office machinery & computers	0.13 [1.50]	1.15	0.17 (2.96)	1.20	0.14 (2.83)	1.17	0.99	136
31 Electrical machinery & apparatus	0.25 [7.85]	1.34	0.28 (14.54)	1.40	0.27 (14.79)	1.38	0.00	550
32 Radio, television, communication equipment	0.32 [7.26]	1.48	0.35 (10.35)	1.53	-	-	-	239
33 Medical, precision instrument	0.30 [5.16]	1.43	0.31 (6.69)	1.44	-	-	-	417
34 Motor vehicles, trailers	0.20 [10.48]	1.25	0.20 (8.10)	1.25	-	-	-	667
35 Other transport equipment	0.17 [4.84]	1.20	0.10 (3.58)	1.11	0.12 (4.59)	1.14	0.00	264
36 Furniture, manufacturing n.e.c.	0.14 [8.15]	1.17	0.14 (7.40)	1.16	-	-	-	691

Notes: The coefficients are almost identical when the industry dummy variables are included in OLS estimation. Square brackets [ ] give White's heteroskedasticity- consistent t-statistics for OLS regression. Standard errors are also adjusted for potential dependency among firms in the same industry. T-statistics and z-statistics in parentheses for fixed- and random-effects estimations. Some of the random-effects estimators are missing because they have degenerated to pooled OLS.

Table 5. Mark-up comparisons with earlier studies

Sector	(1) **Sweden 1991-99**	(2) **Sweden 1980-92**	(3) **Belgium 1992-97**
15 Food and beverage	1.31	1.23	1.30
16 Tobacco	-	-	-
17 Textiles	1.23	1.13	1.35
18 Wearing apparels	1.27	-	1.35
19 Leather, footwear	1.13	1.12	1.19
20 Wood products	1.24	1.16	1.18
21 Pulp and paper	1.34	1.19	1.41
22 Publishing, print	1.45	1.15	1.35
23 Refined petroleum products	1.78	-	1.18
24 Chemicals and chemical products	1.51	1.17	1.33
25 Rubber and plastic products	1.24	1.21	1.37
26 Other non-metallic mineral products	1.33	1.12	1.45
27 Basic metals	1.22	1.09	1.25
28 Fabricated metal products	1.31	1.12	1.19
29 Machinery	1.23	-	1.23
30 Office machinery and computers	1.15	1.17	1.28
31 Electrical machinery and apparatus	1.34	-	1.15
32 Radio, television, communication equipment	1.48	1.30	1.52
33 Medical, precision instrument	1.43	1.12	1.47
34 Motor vehicles, trailers	1.25	1.12	1.30
35 Other transport equipment	1.20	-	1.20
36 Furniture, manufacturing n.e.c.	1.17	1.05	1.30
Average mark-up	1.31	1.15	1.30

for two other small and open economies, Belgium and the Netherlands[15], using firm-level data.

Table 5 shows that in general the estimated mark-ups are higher in this study of Swedish manufacturing industries in the 1990s than in Martins et al. (1996) for the 1980s. The largest differences are found in sectors such as pulp and paper, publishing and print, chemicals and chemical products, and medical and precision instrument. The average mark-up is about 15 percentage points higher in Belgium and Sweden in the 1990s than in Sweden in the 1980s. One might therefore suspect that analyses based on

[15] I do not compare my result with the Netherlands since the number of investigated sectors for the Netherlands is much smaller than for Sweden and Belgium.

Table 6. Spearman rank correlation over time and across countries

	Sweden 1991-1999	**Sweden 1980-1992**	**Belgium 1992-1997**
Sweden 1991-1999	1.00		
Sweden 1980-1992	0.40 (0.12)	1.00	
Belgium 1992-1997	0.31 (0.17)	0.33 (0.20)	1.00

Note: Level of significance in parentheses.

industry data give rise to lower estimates on mark-up levels than those using firm-level data. However, it is also evident from Table 5 that there are notable differences in mark-up levels between sectors in Swedish and Belgian manufacturing. To get a clearer picture of structural variations in mark-ups over time and across countries, I also compute Spearman rank correlations and Table 6 presents the results.

Table 6 indicates that the structural similarity of mark-ups in Swedish manufacturing in the 1980s and in the 1990s is limited; the Spearman rank correlation between the two periods is not significant. An interpretation is that the manufacturing sectors in Sweden have experienced substantial changes in terms of market power/profitability during the period 1980-1999. Potential sources of these changes are both structural changes in the domestic market and the impact of economic integration. Furthermore, we notice that the rank correlation of mark-ups in Sweden and Belgium is also insignificant. Notwithstanding, Sweden and Belgium are both small open economies and members of the EU, the country-specific factors appear to shape the market power structures in these countries.

4.2 Effect of import penetration

Theoretically, import penetration should correlate negatively with the mark-ups due to an increase in demand elasticity or a breakdown of collusive behaviour among dominant producers in the domestic market.

To integrate import competition, as well as domestic competition into my model set-up, I estimate the following regression on the panel of Swedish manufacturing firms in the 1990s discussed in Section 3:

$$\Delta Y_{ijt} = \beta_1 \Delta X_{ijt} + \beta_h \Delta X_{ijt} \times H_{jt} + \beta_{total} \Delta X_{ijt} \times IMC_{jt} + \sum_{t=1992}^{1999} \beta_t \Delta X_{ijt} Year_t +$$

$$+ \gamma_h \times H_{jt} + \gamma_{total} \times IMC_{jt} + \gamma_t Year_t + \varepsilon_{ijt} \qquad (8a)$$

H_{jt} is an employment based Herfindahl index for industries *j* at the SNI92 3-digit level and is an indicator of domestic competition. The import share in consumption in an industry *j*, IMC_{jt}, measures the degree of import competition.[16] The price-cost margin is supposed to be reduced by import competition and to be large when domestic concentration is high in an industry. Thus, we expect β_h to be positive and β_{total} to be negative. The interaction terms between ΔX_{ijt} and year dummies $Year_t$ are included in the specification to capture year-specific effects that may affect the price-cost margins.

In Table 7a, all four estimators: OLS, robust regression, fixed and random effects give the expected negative signs on the coefficient of import penetration.[17] The random-effect, which is the preferred estimator, yields a significant coefficient of the disciplinary effect of import and the point estimate is –0.055. The average import penetration over the estimated period 1991-1999 is 0.44. After taking account for the effect of import competition, at an average level of 0.44, the Lerner index for the manufacturing sector is 0.227 (0.251-0.055x0.44). This implies an average mark-up of 1.29; without import competition the average mark-up is 1.33. Moreover, the parameter estimate of concentration β_h has the expected positive sign and is significant, which indicates that price-cost margins are higher in more concentrated industries.

The coefficients β_ts capture yearly fluctuations and demand effects. Since there were two important institutional events that took place during the studied period – the launch of the EU's internal market in 1992 and Sweden's membership in the EU in 1995 – it is interesting to see whether there has been any effect of the internal market and of the EU membership. Such effects may be captured by the interaction terms between the year dummy variables $Year_t$ and ΔX_{ijt}. Inspection of the β_t reveals no clear decreasing pattern. Put differently, there are year-specific effects associated

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[16] The variables *H* and *IMC* are discussed in more details in Appendix 2.

[17] To check for potential endogeneity problems, I run the same specifications with lagged import penetration of one year and two years and the results turn out to be similar.

Table7a. Effect of import penetration on mark-up in Swedish manufacturing 1990-1999: Total import

	OLS	**Robust regression**	**Fixed-effect**	**Random-effect**
β_1	0.250 [4.98]	0.192 (33.78)	0.255 (17.64)	0.251 (21.26)
Herfindahl β_h	0.134 [1.34]	0.168 (17.87)	0.127 (6.20)	0.134 (7.06)
Total import β_{total}	-0.054 [-0.97]	-0.011 (-3.00)	-0.053 (-6.46)	-0.055 (-7.19)
β_{1992}	-0.037 [-1.31]	0.003 (0.33)	-0.022 (-1.08)	-0.034 (-2.01)
β_{1993}	-0.025 [-0.78]	0.055 (6.14)	-0.043 (-1.95)	-0.027 (-1.47)
β_{1994}	-0.013 [-0.44]	0.040 (4.50)	-0.022 (-1.05)	-0.014 (-0.80)
β_{1995}	-0.002 [-0.01]	-0.005 (-0.56)	-0.000 (-0.02)	0.003 (0.15)
β_{1996}	-0.034 [-1.19]	0.017 (2.09)	-0.032 (-1.62)	-0.033 (-1.93)
β_{1997}	0.056 [1.22]	-0.005 (-0.60)	0.059 (2.84)	0.058 (3.29)
β_{1998}	0.014 [0.48]	-0.006 (-0.71)	0.011 (0.54)	0.013 (0.74)
β_{1999}	-0.005 [-0.16]	-0.007 (-0.77)	-0.013 (-0.56)	-0.008 (-0.45)
Hausman test	-	-	-	0.66
R^2	0.52		Within: 0.54 Between: 0.33 Overall: 0.52	Within: 0.54 Between: 0.33 Overall: 0.52
Number of observations	12959	12959	12959	12959

Notes: OLS standard errors are adjusted for heteroskedasticity and potential dependency among firms in the same industry.

with the size of mark-ups, but there is no clear-cut evidence indicating that these year-specific effects are related to the institutional changes. On the other hand, the relatively short time span of this study may not make it possible to identify any long-run effect.

In Section 3, I argue that the impact of imports on mark-ups may vary depending on the country of origin and I proposed that import should be divided into five country groups. To allow for differential disciplinary effects of imports, I have adjusted the model in Equation (8a). Equation (8b) below shows the relevant parts.

$$\Delta Y_{ijt} = \beta_1 \Delta X_{ijt} + \ldots + \sum_{k=1}^{5} \beta_k \Delta X_{ijt} IMC_{jkt} + \ldots + \sum_{k=1}^{5} \gamma_k IMC_{jkt} + \ldots + \varepsilon_{ijt} \qquad (8b)$$

where IMC_{jkt} is the share of import from country group k in industry j at time t.

The results in Table 7b suggest that the effects of import penetration do vary depending on the origins of imports.[18] The imports from the new EU member countries have negative and significant effects in all specifications. When I control for unobserved firm-specific effects, imports from the former EU member countries and Japan and Asian NICs affect price-cost margins negatively as well.

The imports from other low-income countries do not impose any disciplinary effect. On the contrary, the coefficient is positive and statistically significant. By inspecting the import composition from low-income countries in Table 2, we notice that, except labour intensive imports such as wearing apparels and footwear, a considerable part of the imports from low-income countries belongs to sectors such as petroleum products, basic metal and radio and telecommunications. The positive effect on mark-ups of imports from low-income countries may imply that these imports, rather than price-competing, are cost-reducing for Swedish manufacturing firms. One possible explanation is that Swedish firms take advantage of low cost components from the low-income imports in their production.

I have recognized that the disciplinary effects of imports differ depending on the origins of imports. Another interesting question is whether the impact of import penetration may vary due to product differentiation. I examine the differential effects associated with product differentiation by adapting Equation (8a).

$$\Delta Y_{ijt} = \beta_1 \Delta X_{ijt} + \ldots + \beta_{total} \Delta X_{ijt} IMC_{jt} + \beta_{totdiff} \Delta X_{ijt} IMC_{jt} \times Diff_j + \ldots$$
$$+ \beta_{diff} \Delta X_{ijt} \times Diff_j + \ldots + \gamma_{diff} Diff_j + \ldots + \varepsilon_{ijt} \qquad (9)$$

[18] Estimations with one- and two-year lags of import penetration from different country groups give similar results.

Table 7b. Effect of import penetration on mark-up in Swedish manufacturing 1990-1999: Five country groups

	OLS	**Robust Reg**	**Fixed-effect**	**Random-effect**
β_1	0.254 [5.05]	0.197 (35.30)	0.258 (17.93)	0.255 (21.59)
Herfindahl β_h	0.124 [1.23]	0.156 (16.81)	0.118 (5.73)	0.124 (6.52)
Import EU14 β_{eu14}	-0.040 [-0.59]	-0.020 (-3.39)	-0.037 (-2.81)	-0.039 (-3.81)
Import EU10 β_{eu10}	-2.363 [-3.28]	-1.921 (-19.81)	-2.545 (-11.59)	-2.411 (-12.02)
Import Japan and Asian NICs $\beta_{j\&n}$	-0.161 [-1.24]	-0.011 (-0.46)	-0.157 (-3.00)	-0.163 (-3.39)
Import other high income countries $\beta_{high-income}$	-0.066 [-0.56]	0.012 (0.69)	-0.061 (-1.62)	-0.067 (-1.93)
Import other low-income countries $\beta_{low-income}$	0.276 [2.27]	0.172 (5.86)	0.255 (3.87)	0.268 (4.42)
Year dummies	yes	yes	yes	yes
Hausman test	-	-	-	0.29
R^2	0.52		Within: 0.55 Between: 0.32 Overall: 0.52	Within: 0.55 Between: 0.33 Overall: 0.52
Number of observations	12959	12959	12959	12959

Notes: OLS standard errors are adjusted for heteroskedasticity and potential dependency among firms in the same industry.

The dummy variable $Diff_j$, which equals one if the firm is in a sector that produces high-differentiated goods, is a proxy for product differentiation. The definition of high- and low-differentiated sectors is given in Section 3. The coefficient β_{diff} captures a direct effect of product differentiation on price-cost margins. The coefficient β_{total} measures the effect of import penetration in the low-differentiated sector, while the estimate of $\beta_{totdiff}$ shows the differential effect of import penetration in the high-differentiated sector. Theoretically, both vertical and horizontal differentiations may relax price competition in the market. However, it depends on the relative demand elasticity and the degree to which the imported and domestic goods are substitutes to each other. We cannot *a priori* determine the sign of the interactive term. A negative sign of $\beta_{totdiff}$ indicates a stronger disciplinary effect of imports in the high-differentiated sector, while a positive sign suggests a weakened disciplinary effect.[19]

Table 8a. Import penetration and product differentiation: Total import

	OLS	**Robust Reg.**	**Fixed-effect**	**Random-effect**
β_1	0.261 [4.94]	0.198 (33.86)	0.265 (18.24)	0.261 (21.83)
Herfindahl β_h	0.211 [2.38]	0.174 (16.77)	0.205 (9.28)	0.210 (10.22)
Total import β_{total}	-0.097 [-1.49]	-0.037 (-6.83)	-0.101 (-8.98)	-0.099 (-9.39)
Total import × Product differentiation $\beta_{totdiff}$	0.178 [2.12]	0.066 (5.44)	0.201 (7.73)	0.183 (7.63)
Product differentiation β_{diff}	-0.095 [-2.00]	-0.023 (-3.37)	-0.105 (-6.99)	-0.097 (-6.97)
Year dummies	yes	yes	yes	yes
Hausman test	-	-	-	0.47
R^2	0.54		Within: 0.56 Between: 0.32 Overall: 0.53	Within: 0.56 Between: 0.32 Overall: 0.53
Number of observations	12140	12140	12140	12140

Notes: OLS standard errors are adjusted for heteroskedasticity and potential dependency among firms in the same industry.

[19] As a robustness check I replace the product differentiation dummy variable $Diff$ with the R&D intensity – the ratio of R&D expenditures to total sales – at industry level. Yet, I prefer the dummy variable specification. First, the dummy variable provides a more straightforward interpretation. Second, the R&D intensity may induce additional measurement errors and endogeneity bias. However, the alternative proxy of product differentiation yields similar results. Table A3.1 in Appendix 3 presents the results using R&D intensity as a proxy for product differentiation.

The results in Table 8a from estimating the model in Equation (9), allowing for differential impact of import penetration owing to product differentiation, show that the disciplinary effect of import appears to vary with the degree of product differentiation. The negative and significant coefficients of β_{total} in the fixed- and random effect models indicate that total import imposes a disciplinary effect in the low-differentiated sector. However, the positive and significant coefficients of the interaction terms between total import and product differentiation $\beta_{totdiff}$ imply that the disciplinary effect of import is weaker in the high-differentiated sector.

When both product differentiation and imports from various country groups are explicitly included into the estimated model, as shown by the results in Table 8b, the disciplinary effects of imports from the former EU members countries, the recent EU members, and Japan and Asian NICs remain significant in the low-differentiated sector. However, imports from high-income countries do not have any significant effect on price-cost margins. The disciplinary effects of imports in the high-differentiated sector, indicated by the interaction terms between import penetration and the differentiation dummy variable, suggest that the effects imposed by the imports from the former EU member countries and the recent EU members are weakened substantially in the high-differentiated sector. The imports from Japan and Asian NICs and other high-income countries do not have any significant effect in the high-differentiated sector. For the low-income counties, the effects are positive and significant in both the low- and the high-differentiated sectors.

To get a clearer picture of how price-cost margins are affected by imports from different origins and in differentiated markets, I calculate the net-effects by using the sample means of import penetrations and significant random-effect coefficients in Table 8b above. I report the results in Table 9.

The results shown in Table 9 indicate that the disciplinary effects imposed by imports from the recent EU members, the former EU members, and Japan and Asian NICs are stronger in the low-differentiated sector than in the high-differentiated sector. Perhaps due to large amounts of intra-industry trade, imports from these country groups do not have any disciplinary effect in the high-differentiated sector. This implies, on the one hand, that firms from the EU member countries do not have apparent cost advantages compared to their competitors in Swedish market. This also means, on the other hand that Swedish manufacturing firms manage to keep higher prices, through either vertical or horizontal product differentiation, thanks to quality superiority or competitive product varieties.

Table 8b. Import penetration and product differentiation: Import divided into five country groups.

	OLS	**Robust Reg**	**Fixed-effect**	**Random-effect**
β_1	0.261 [4.97]	0.200 (34.80)	0.266 (18.29)	0.262 (21.84)
Herfindahl β_h	0.218 [2.38]	0.158 (14.79)	0.214 (9.22)	0.216 (10.03)
Import EU14 β_{eu14}	-0.082 [-1.16]	-0.020 (-2.10)	-0.078 (-3.77)	-0.079 (-4.14)
Import EU10 β_{eu10}	-2.675 [-3.36]	-2.207 (-20.65)	-2.825 (-11.86)	-2.732 (-12.52)
Import Japan and Asian NICs $\beta_{j\&n}$	-0.311 [-1.16]	-0.074 (-1.32)	-0.297 (-2.36)	-0.314 (-2.75)
Import other high income countries $\beta_{high-income}$	0.097 [0.52]	0.072 (2.27)	0.059 (0.85)	0.078 (1.22)
Import other low-income countries $\beta_{low-income}$	0.244 [1.36]	0.148 (4.04)	0.223 (2.74)	0.236 (3.18)
Import EU14 × product differentiation $\beta_{eu14diff}$	0.218 [1.73]	0.012 (0.71)	0.236 (6.14)	0.218 (6.17)
Import EU10 × product differentiation $\beta_{eu10diff}$	1.864 [1.48]	1.033 (4.03)	1.905 (3.36)	1.946 (3.73)
Import Japan & NIC × product differentiation $\beta_{j\&ndiff}$	0.131 [0.43]	-0.013 (-0.20)	0.115 (0.81)	0.130 (1.00)
Import other high-income × product differentiation $\beta_{highdiff}$	-0.127 [-0.56]	-0.047 (-1.20)	-0.055 (-0.64)	-0.098 (-1.23)
Import other low-income × product differentiation $\beta_{lowdiff}$	0.834 [1.61]	0.678 (6.94)	0.868 (4.00)	0.843 (4.24)

Table 8b. (continued)

Product differentiation β_{diff}	-0.107 [-2.06]	-0.014 (-1.88)	-0.120 (-7.32)	-0.109 (-7.30)
Year dummies	yes	yes	yes	yes
Hausman test	-	-	-	0.29
R^2	0.52		Within: 0.57	Within: 0.57
			Between: 0.32	Between: 0.33
			Overall: 0.53	Overall: 0.54
Number of observations	12140	12140	12140	12140

Notes: OLS standard errors are adjusted for heteroskedasticity and potential dependency among firms in the same industry.

Table 9. Import penetration in low- and high-differentiated sectors

Country group	**Import penetration Low-differentiated sector**	**Import penetration High-differentiated sector**	**F- test for joint effect**
EU14 members	-0.079x0.31 = -0.02	(-0.079+0.218)x0.31 = 0.04	0.00
EU10 recent members	-2.732 x0.01 =-0.03	(-2.732+1.946)x0.01 =-0.008	0.00
Japan and Asian NICs	-0.314x0.03 =-0.01	-	0.00
Low-income countries	0.236x0.02 =0.005	(0.236+0.843)x0.02 =0.02	0.00

The above results show that Swedish manufacturing firms are able to sustain higher price-cost margins in the high-differentiated sector in the face of intensive import competition. Nevertheless, the competitiveness is not costless. This is indicated by the negative and significant coefficient of β_{diff} . We observe that product differentiation does in fact increase costs for producers, while at the same time reducing the price-cost margins.

5. Concluding remarks

By applying Roeger’s method to estimate price-cost margins I find that Swedish manufacturing firms in 1990s, on average, have a mark-up of 30 percent. This is similar to the average mark-up levels obtained in previous studies based on firm-level data for other small and open economies that employ the same estimating approach. Yet there are notable differences in mark-up levels in various sectors between countries.

The excessive profitability levels are indeed affected by competition pressure in Swedish manufacturing. First, price-cost margins are reduced by the total import penetration. Second, when the total imports are divided into country groups, it turns out that the strengths of the disciplinary effect vary depending on the origins of imports. The imports from the recent EU member countries seem to impose the strongest disciplinary effect. Also, the imports from the former EU countries, Japan and Asian NICs and other high-income countries appear to have disciplinary effects on mark-up levels, although somewhat weaker owing to the intra-industry nature of imports from these countries.

Finally, when product differentiation is taken into account the disciplinary effect of import is in general weaker in the high-differentiated sector. This is compatible with the theoretical prediction that product differentiation (both vertical and horizontal) relaxes price competition in the market.

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Appendix 1 Derivation of primal and dual Solow residuals

The primal analysis

Log-differentiation of the production function in Equation (1) in Section 2 gives

$$\hat{Q}_{it} = \hat{A}_{it} + \alpha_{iKt}\hat{K}_{it} + \alpha_{iSt}\hat{S}_{it} + \alpha_{iUt}\hat{U}_{it} + \alpha_{iMt}\hat{M}_{it} \quad \text{(A.1)}$$

α_{iJt} is the elasticity of output with respect to input *J*, which in turn equals the factor *J*'s share of total cost, i.e. $\alpha_{iJt} = w_{Jit}J_{it} / m_{it}Q_{it}$, where w_{Jit} is the price of factor *J* and m_{it} is marginal cost.

The mark-up, price over marginal cost, is $\mu_{it} = p_{it} / m_{it}$ and the share of factor *J* in total revenue $\theta_{Jit} = w_{Jit}J_{it} / p_{it}Q_{it}$. We can write the cost share of factor *J* as:

$$\alpha_{Jit} = \left(\frac{p_{it}}{m_{it}}\right)\left(\frac{w_{Jit}J_{it}}{p_{it}Q_{it}}\right) = \mu_{it}\theta_{Jit} \quad \text{(A.2)}$$

Under perfect competition $\alpha_{Jit} = \theta_{Jit}$, while imperfect competition implies that $\mu_{it} > 1$ and hence $\alpha_{Jit} > \theta_{Jit}$.

We assume constant returns to scale and from Euler's theorem we know that:

$$\sum_{J=K,S,U,M} \alpha_{Jit} = 1 \quad \text{(A.3)}$$

Using (A.3), substituting (A.2), and adding $\hat{Q}_{it}$ and subtracting $\hat{K}_{it}$ from both sides of Equation (A.1) gives the Solow residual SR_{it}:

$$SR_{it} = \hat{Q}_{it} - (1 - \theta_{iSt} - \theta_{iUt} - \theta_{iMt})\hat{K}_{it} - \theta_{iSt}\hat{S}_{it} - \theta_{iUt}\hat{U}_{it} - \theta_{iMt}\hat{M}_{it} =$$

$$\mu_{it}^{-1}\hat{A}_{it} + \left(1 - \mu_{it}^{-1}\right)\hat{Q}_{it} - \left(1 - \mu_{it}^{-1}\right)\hat{K}_{it} \qquad \text{(A.4)}$$

A common measure of market power, which is closely related to the mark-up, is the Lerner index or price-cost margin β_{it}:

$$\beta_{it} = \frac{p_{it} - m_{it}}{p_{it}} = 1 - \frac{1}{\mu_{it}} \quad \text{or} \quad \mu_{it} = \frac{p_{it}}{m_{it}} = \frac{1}{1 - \beta_{it}} \qquad \text{(A.5)}$$

We replace the mark-up with the Lerner index in (A.5) and obtain:

$$SR_{it} = (1 - \beta_{it})\hat{A}_{it} + \beta_{it}\left(\hat{Q}_{it} - \hat{K}_{it}\right) \qquad \text{(A.6)}$$

The dual analysis

The cost function that corresponds to firm *i*'s production function in Equation (1) in Section 2 is:

$$C_i\left(w_{iKt}, w_{iSt}, w_{iUt}, w_{iMt}, Q_{it}, A_{it}\right) = \frac{G_i\left(w_{iKt}, \ldots w_{iMt}\right)Q_{it}}{A_{it}} \qquad \text{(A.7)}$$

and the marginal cost function is:

$$m_{it} = \frac{G_i\left(w_{iKt}, \ldots w_{iMt}\right)}{A_{it}} \qquad \text{(A.8)}$$

Log-differentiation of (A.8), making use of Shepard's lemma, which means that $(\partial G_i / \partial w_J) = J_{it} A_{it} / Q_{it}$, and total cost $C_{it} = G_{it} Q_{it} / A_{it}$, we get the following expression:

$$\hat{m}_{it} = \hat{A}_{it} + \alpha_{iKt} \hat{w}_{Kt} + \alpha_{iSt} \hat{w}_{St} + \alpha_{iUt} \hat{w}_{Ut} + \alpha_{iMt} \hat{w}_{Mt} \qquad \text{(A.9)}$$

Assuming constant mark-up over the period *t* implies:

$$\hat{p}_{it} = \hat{m}_{it} \qquad \text{(A.10)}$$

Replacing $\hat{m}_{it}$ with $\hat{p}_{it}$, using (A.3) and substituting (A.2), adding $\hat{w}_{iKt}$ and subtracting $\hat{p}_{it}$ from both sides of Equation (A.9) gives the price-based Solow residual SRP_{it}:

$$SRP_{it} = (1 - \theta_{iSt} - \theta_{iUt} - \theta_{iMt})\hat{w}_{iKt} + \theta_{iSt}\hat{w}_{iSt} + \theta_{iUt}\hat{w}_{iUt} + \theta_{iM}\hat{w}_{iMt} - \hat{p}_{it} =$$
$$\mu_{it}^{-1}\hat{A}_{it} + (1 - \mu_{it}^{-1})\hat{w}_{iKt} - (1 - \mu_{it}^{-1})\hat{p}_{it} \qquad \text{(A.11)}$$

By replacing the mark-up with the Lerner index from (A.5) we get:

$$SRP_{it} = (1 - \beta_{it})\hat{A}_{it} - \beta_{it}(\hat{p}_{it} - \hat{w}_{Kt}) \qquad \text{(A.12)}$$

Appendix 2 Definition of variables, panel information and country groups

Rental price of capital

Following Hall and Jorgenson (1967) the rental price of capital in firm *i* in industry *j* at time *t* is derived:

$$R_{ijt} = \left[\left(i_t - \pi_t\right) + \delta_{it}\right] * p_{jt}$$

i_t : Long-run nominal interest rates proxied by yields on public sector bonds of 10 years maturity.
π_t : Expected inflation rate.
δ_{it} : Firm-specific rate of depreciation.
p_{jt} : Industry-specific deflator for fixed business investment.

In the dataset capital stocks are divided into building and machinery, i.e. $K_{ijt} = K_{ijt}^B + K_{ijt}^M$. Depreciation rates and deflators are defined as weighted averages:

$$\delta_{it} = \frac{K_{it}^B}{K_{it}^B + K_{it}^M}\delta^B + \frac{K_{it}^M}{K_{it}^B + K_{it}^M}\delta^M \quad \text{and} \quad p_{jt} = \frac{K_{jt}^B}{K_{jt}^B + K_{jt}^M} p_{jt}^B + \frac{K_{jt}^M}{K_{jt}^B + K_{jt}^M} p_{jt}^M$$

The depreciation rate for building δ^B is 3 percent and 11 percent for machinery δ^M. p_{jt}^k are industry-specific deflators for building and machinery, $k = B, M$.

Measurements of competition

Domestic competition

Herfindahl index: $H_j = \sum_{i=1}^{N} S_{ij}^2$, where S_{ij} is the market share in term of employment of firm *i* in industry *j*. By using data on employment from RAMS (Register-based labour market statistics) I can calculate the Herfindahl index for the period 1990-1999 where all Swedish manufacturing firms are included. Herfindahl index based on production, which contains all firms, can only be calculated for the period 1996-1999. However, the employment- and production-based Herfindahl indexes are strongly correlated (0.96) for the period 1996-1999.

Import competition

Import penetration ratio: import as a fraction of domestic consumption. Consumption is defined as: Sales value + import – export.

Table A2.1 Panel information

Year	**Number of firms**
1990	1921
1991	1853
1992	1706
1993	1542
1994	1551
1995	1623
1996	1696
1997	1674
1998	1737
1999	1755
Total number of firm-years: 17058	
Years in the panel	**Number of firms**
10	816
9	150
8	135
7	161
6	173
5	174
4	232
3	348
2	453
1	555
Total number of firms: 3197	

Table A2.2 Country group classification

EU14 members (excl. Sweden)	EU10 recent members	Japan and Asian NICs	Other high-income countries	Other low-income countries
Belgium	Czech	Japan	Australia	Mexico
Demark	Estonia	Taiwan	Canada	Bulgaria
Germany	Cyprus	Hong Kong	Iceland	Turkey
Greece	Latvia	South Korea	New Zealand	Romania
Spain	Lithuania	Singapore	Norway	Other low-income countries
France	Hungary		Switzerland	
Ireland	Malta		United States	
Italy	Poland			
Luxembourg	Slovenia			
The Netherlands	Slovakia			
Austria				
Portugal				
Finland				
United Kingdom				

Appendix 3 Additional results

Table A3.1 Import penetration and product differentiation: R&D intensity as a measure of product differentiation

	OLS	**Robust Reg.**	**Fixed-effect**	**Random-effect**
β_1	0.259 [4.96]	0.200 (34.94)	0.262 (18.08)	0.259 (21.77)
Herfindahl β_h	0.161 [1.72]	0.150 (14.79)	0.152 (6.89)	0.158 (7.75)
Import EU14 β_{eu14}	-0.043 [-0.62]	-0.031 (-4.63)	-0.051 (-3.54)	-0.044 (-3.38)
Import EU10 β_{eu10}	-2.444 [-3.28]	-1.980 (-19.37)	-2.543 (-11.21)	-2.479 (-11.94)
Import Japan and Asian NICs $\beta_{j\&n}$	-0.203 [-1.56]	-0.017 (-0.62)	-0.143 (-2.44)	-0.191 (-3.58)
Import other high income countries $\beta_{high-income}$	-0.137 [-1.05]	0.023 (1.17)	-0.103 (-2.45)	-0.131 (-3.39)
Import other low-income countries $\beta_{low-income}$	0.300 [2.39]	0.195 (6.25)	0.271 (3.91)	0.290 (4.59)
Import EU14 × R&D intensity β_{eu14rd}	0.175 [0.29]	0.594 (4.10)	0.615 (2.05)	0.257 (0.94)
Import EU10 × R&D intensity β_{eu10rd}	17.508 [0.83]	19.509 (4.31)	16.066 (1.52)	18.806 (2.02)
Import Japan & NIC × R&D intensity $\beta_{j\&nrd}$	-0.355 [-0.33]	-0.247 (-0.61)	-1.450 (-1.77)	-0.642 (-0.86)

Table A3.1 (continued)

Import other high-income × R&D intensity β_{highrd}	0.823 [0.84]	-0.856 (-2.82)	-0.365 (-0.60)	0.554 (1.00)
Import other low-income × R&D intensity β_{lowrd}	-0.661 [-0.19]	-2.272 (-1.76)	-2.045 (-0.72)	-0.997 (-0.39)
R&D intensity β_{rd}	0.096 [0.42]	0.024 (0.54)	0.142 (1.48)	0.116 (1.30)
Year dummies	yes	yes	yes	yes
Hausman test	-	-	-	0.00
R^2	0.53		Within: 0.57	Within: 0.57
			Between: 0.32	Between: 0.33
			Overall: 0.53	Overall: 0.54
Number of observations	12140	12140	12140	12140

Notes: OLS standard errors are adjusted for heteroskedasticity and potential dependency among firms in the same industry. R&D outlays are from the financial accounts of enterprises.

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