DISCUSSION PAPER SERIES

No. 4568

PRICING TO FIRM: AN ANALYSIS OF FIRM- AND PRODUCT-LEVEL IMPORT PRICES

László Halpern and Miklós Koren

INTERNATIONAL MACROECONOMICS and TRANSITION ECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP4568.asp**

ISSN 0265-8003

PRICING TO FIRM: AN ANALYSIS OF FIRM- AND PRODUCT-LEVEL IMPORT PRICES

László Halpern, Institute of Economics, Hungarian Academy of Sciences, CEU, WDI and CEPR
Miklós Koren, Harvard University and Institute of Economics, Hungarian Academy of Sciences

Discussion Paper No. 4568
August 2004

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 4568

August 2004

ABSTRACT

Pricing to Firm: An Analysis of Firm- and Product-Level Import Prices*

We use Hungarian customs data on product-level imports and exports of manufacturing firms to document that the import price of a particular product varies substantially across buying firms. Importantly, we can relate the level of import prices to firm characteristics such as size, foreign ownership and market power. We develop a theory of 'pricing to firm' (PTF), where mark-ups depend on the technology and competitive environment of the buyer. The predictions of the model are confirmed by the data: import prices are higher for firms with greater market power, and for intermediate inputs with a high share in material costs. We take account of the endogeneity of the buyer's market power with respect to higher import prices. We show that even if unobserved cost heterogeneity within product categories is substantial, it is uncorrelated with our variables of interest. The magnitude of PTF is big: the standard deviation of price predicted by PTF is 21.5%.

JEL Classification: D43, F14 and F23
Keywords: import prices, price discrimination and pricing to firm

László Halpern
Institute of Economics
Hungarian Academy of Sciences,
Budaörsi 45
H-1112 Budapest
HUNGARY
Tel: (36 1) 397 6180
Fax: (36 1) 319 3136
Email: halpern@econ.core.hu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=105353

Miklós Koren
Institute of Economics
Hungarian Academy of Sciences,
Budaörsi 45
H-1112 Budapest
HUNGARY
Tel: (36 1) 309 2666
Email: koren@econ.core.hu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=139516

*We thank Pol Antràs, Gábor Kőrösi, Deborah Swenson, Silvana Tenreyro, János Vincze and seminar participants at Harvard, the Institute of Economics, and the 'Empirical Investigations in International Economics' conference at the University of Ljubljana for comments and Ágnes Nagy for help with the data. Any remaining errors are ours.

Submitted 05 July 2004

1. Introduction

This paper analyzes the variation of import unit values of particular goods across different importing firms. We use the Hungarian Customs Statistics to construct a rich panel dataset of the product-level export and import flows of Hungarian manufacturing firms. This enables us to identify the use and pricing of imported goods directly at the firm level.

A first look at our data reveals several interesting features. First, import prices vary hugely across buyers (the standard deviation of log price within products is 1.37), the more so, the more differentiated the product is. Second, a significant part of this variation is specific to buyers. That is, some firms buy most of their inputs at a higher price than others. Across the whole range of products, 14% of the total variance is explained by firm fixed effects. In contrast, market and year fixed effects account for only 6% of the variance. In other words, knowing *who* buys the product is more than twice as informative of its price as knowing *when and where* the trade originates. This means that micro information at the firm level is at least as important as macro phenomena (e.g., exchange rate movements, monetary and fiscal policy) in explaining import prices. Third, the variation across firms relates meaningfully to observable firm characteristics, such as firm size, ownership, use of intermediates, and performance. In particular, the relationships conform to our theory of buyer-specific product differentiation.

In contrast to most international trade models that postulate organized goods markets with anonymous buyers and sellers, we build a model in which sellers choose to differentiate their goods across buyers and charge different markups based on the observable characteristics of the buyer. We term the phenomenon of buyer-specific markups "pricing to firm" (PTF).

It is standard practice to assume that products are differentiated by producers, e.g., Budweiser is an imperfect substitute for Heineken. (See an excellent survey in Helpman (1999).) Intuitively, producers are motivated to develop different brands so that they can extract monopolistic rents from consumers. According to Rauch (1999, p 16), differentiated goods comprised $65-67\%$ of world merchandise trade in 1990.

However, most of international trade takes place in a setting where not only buyers are able to identify the producers but producers also see who they sell their product to. A growing body of literature documents the empirical relevance of

buyer-seller relationships in trade. As Egan and Mody (1992, p 326) document, the relationship between buyers and cross-border sellers lasts for an average of 8 to 12 years in five developed economies. Existing theoretical (e.g., McLaren (1999), Grossman and Helpman (2003), Antràs and Helpman (2003)) and empirical works (e.g., Gereffi (1999), Hanson, Mataloni and Slaughter (2003), Hummels, Ishii and Yi (2001)) on this topic usually focus on developed-country producers outsourcing some of their activities to developing countries. The main themes of the literature are (i) why and when producers choose global outsourcing over domestic production, and (ii) how the buyer-supplier link enables suppliers to keep up with quality requirements of their buyers. To the best of our knowledge, this paper is the first to look at firm-level import data to uncover patterns of buyer-specific product differentiation. An additional difference of our approach to previous studies lies in our focus on transition economy firms as buyers and (plausibly) industrial-country suppliers,[1] that have the potential to price-discriminate across buyers.

We focus on a particular aspect of buyer-seller relationships, namely, on how sellers price their products. The price charged for buyers may depend on their bargaining power (e.g., firm size, import market experience) or their outside alternatives (e.g., highly specialized accessories are harder to substitute than homogeneous supplies). Obviously, in order to be able to charge different prices for different buyers, the supplier needs to segment its output markets effectively. Otherwise, arbitrage across buyers would prevent any price differential. We believe that a wide range of products entering international trade is actually tailored for the buyer's needs, preventing profitable resale. Buyer-specific elements may include customization, installation, and after-sale services.[2]

We then test the implications of the model by looking at how various firm characteristics affect the price at which they acquire their imports. One obvious reason for the wide dispersion of product prices across buyers is the heterogeneity within product categories. Even in the 6-digit Harmonized System classification, which we use, products with very different unit values can be grouped together. A key question in our empirical strategy is how we can distinguish cost differences (quality heterogeneity) from markup differences (pricing to firm). In particular, we

1. Though we do not observe the source country of imports at the firm level, we have to note that in 2001, 69.4% of Hungarian imports originated from developed countries.

2. Theoretically, it is in the best interest of the producer to provide customization to erode the value of outside alternatives and to lock in the buyer in a long-term relationship.

need to make sure that cost heterogeneity is not correlated with the characteristics of buying firms that we focus on. We ensure this by (i) using instrumental variables techniques, and (ii) judging the behavior of our model in a "control group" of products which exhibit substantial cost heterogeneity but no markup differences (homogeneous products).

Our results can be summarized as follows. First, both the market power and the technology (e.g., share of the particular input among intermediates) of the buyer have a significant impact on the import price. Importantly, we distinguish two concepts of market power with very different consequences: the share of the firm in the import market lowers the import price, whereas its power in the export market raises the price of inputs. Second, the magnitude of the effect on the import price is big. The standard deviation of price predicted by PTF is 21.5%. Finally, we show that even if unobserved cost heterogeneity within product categories is substantial, it is uncorrelated with our variables of interest. In other words, we only find evidence of PTF in differentiated product markets and not in homogeneous product categories.

The rest of the paper is structured as follows. Section 2 introduces our model of pricing to firm, deriving the markup charged for a firm from its technology and market structure. Section 3 describes our dataset and the empirical specifications of the model. Section 4 presents the results that confirm the predictions of the pricing-to-firm framework. Finally, Section 5 concludes. A data appendix accompanies the paper with detailed variable definitions.

2. A Model of Pricing to Firm

In explaining the observed price differences across buyers, we allow for three channels: (i) differences in costs (potentially due to quality), (ii) second-degree price discrimination (nonlinear pricing), and (iii) third-degree price discrimination. First, some firms may buy higher quality products (within the same product category) than others. Importantly, the need for quality may be related to particular characteristics of the firm (export orientation, size, etc.) Second, sellers may employ nonlinear price schedules giving discounts for bulk buyers. Third, the price sellers charge may depend on the price elasticity of particular buyers. In particular, buyers with less elastic demand will face higher markups and higher prices. Then the question is what determines the elasticity of demand for inputs

at the firm level. Section 2.1 derives this elasticity from the technology applied by the firm and its competitive pressure in its output market.

2.1. THIRD-DEGREE PRICE DISCRIMINATION

Third-degree price discrimination rests on the assumption that firms can charge different prices to (groups of) buyers with different observable characteristics. The price charged to buyer k will follow the "inverse elasticity rule,"

$$P_k = \frac{1}{1 - 1/\sigma_k} C, \tag{1}$$

where σ_k is the elasticity of demand of buyer k and C is marginal cost. The higher the elasticity of demand of a particular buyer, the lower the price for that buyer.

The elasticity of demand in turn depends on the characteristics of the buyer. Given that we consider intermediate inputs as goods and manufacturing firms as buyers, the relevant characteristics include the production technology of firm k and the market structure in which it operates,

$$\sigma_k = f(\text{technology}_k, \text{market structure}_k).$$

Demand for imported inputs is derived from the marginal product of the input. More specifically, let the importing firm use the following production function

$$Q = \left[(1-\beta)^{1/\phi} L^{1-1/\phi} + \beta^{1/\phi} X^{1-1/\phi}\right]^{\phi/(\phi-1)},$$
$$X = \left[\sum_i X_i^{1-1/\theta}\right]^{\theta/(\theta-1)}.$$

That is, the firm combines labor and intermediate inputs (capital is omitted for brevity) with elasticity of substitution ϕ. Intermediate input is a constant-elasticity-of-substitution (CES) composite of the individual inputs, X_is, with a substitution elasticity of θ. We assume that $\theta > \phi$, that is, an intermediate input is closer substitute of another input than of labor. The share of intermediates in total cost is governed mainly by the parameter β.

Each input supplier takes the quantities of other input sellers as given. What is then the demand elasticity for intermediate input i? Let R_i denote the price of input i, R the composite price of inputs, and C the marginal cost of production. By standard rules of nested CES production functions, these can be expressed as

follows:

$$R_i = R\left(\frac{X_i}{X}\right)^{-1/\theta}$$
$$R = \beta\left(\frac{X}{CQ}\right)^{-1/\phi},$$

or, in logs,

$$r_i = -x_i/\theta - (1/\phi - 1/\theta)x + \ln\beta + (c+q)/\phi.$$

We wish to determine the elasticity of the marginal product of input i, $\mathrm{d}r_i/\,\mathrm{d}x_i$. Let s_i denote the share of input i in the expenditure on intermediates. This implies $\mathrm{d}x/\,\mathrm{d}x_i = s_i$. Assume that the final good producer faces a demand curve with constant elasticity ε and charges a constant markup of $\mu = 1/(1-1/\varepsilon)$. Then a one percent increase in marginal cost leads to a ε percent decrease in output.

$$\frac{\mathrm{d}r_i}{\mathrm{d}x_i} = -1/\theta - s_i(1/\phi - 1/\theta) + \beta s_i(1-1/\varepsilon)/\phi.$$

The inverse of the demand elasticity is then

$$\frac{1}{\sigma} = 1/\theta + s_i(1/\phi - 1/\theta) - \beta s_i/\mu\phi. \tag{2}$$

Demand for the input is less elastic (and the price is higher) if

(i) other intermediates are poor substitutes (θ is low)

(ii) the share of input i among intermediates (s_i) is high

(iii) intermediates are less essential in production (βs_i is low)

(iv) output markup (μ) is high.

First, if it is easier to substitute away from input i, firms will cut their sale more in response to a given price increase. Notice that if the input is not differentiated, the elasticity of substitution is very high, and the input should sell at marginal cost.

Second, if the share of an input among intermediates is high, then the elasticity of its marginal product will also decline because of the decreasing returns to the composite input, X. That is, the marginal product is more downward sloping for

inputs with greater shares, resulting in a less elastic demand schedule.[3] This is very similar to standard Cournot competition where the elasticity of residual demand depends inversely on the market share of the seller, but here the seller competes with with suppliers of *other* intermediate inputs. Monopolistic competition results as a special case when the market share of each supplier is negligible, $s_i \to 0$. Then the elasticity of demand is just θ.

Finally, if the input constitutes a non-negligible share of total marginal cost (βs_i is big), then the seller also takes into account the feedback effect of a rising marginal cost when setting its price. In particular, a rising cost results in a decline of demand for the final good producer's output, hence a decline of demand for intermediate inputs. The stiffer the competition in the output market (μ is lower), the more this is so. On the one hand, perfectly competitive firms cannot tolerate any (firm-specific) change in their marginal cost so their input demand will be highly elastic. On the other hand, if the buyer has considerable market power, it can pass on large swings in marginal costs to consumers without affecting output too much. Such a firm will be less price-sensitive in its input markets. As already pointed out above, the intensity with which competition in the output market affects the demand for the given input is proportional to its share in total cost, βs_i.

2.2. EMPIRICAL IMPLICATIONS

Given the richness of our dataset, we can test the predictions concerning the elasticity of input demand quite extensively. Recall from (2) that the elasticity of demand depends on (i) the substitutability of intermediate goods, (ii) the share of the given product among intermediates, (iii) the share of the given product in total cost, and (iv) the output markup of the buyer.

We do not measure or estimate substitutability of inputs directly. However, we can compare the import pricing results for several broader product categories. It is plausible to assume that the more differentiated a product is, the harder it is to substitute with another product.

3. Note that we assumed $\theta > \phi$, that is, intermediate inputs are closer substitutes than other factors of production.

The financial statements contain data on costs of materials, which we can use to calculate the necessary cost shares. Section 3 provides further discussion on data definition.

Since we observe the amount imported by firms (in both forints and metric tons), we can also consider a simple prediction of second-degree price discrimination, namely that firms buying more of a product enjoy lower price *ceteris paribus*.

3. Data and Specification Issues

The dataset consists of a panel of Hungarian exporting companies from 1992 to 2001. It has three major dimensions: firms, products and time. Data were matched from three different sources, the Customs Statistics, the firms' balance sheet and earnings statement data, and Eurostat's Extra-EU Trade Statistics. The dataset contains the balance sheets and financial statements of the firms, as well as their annual export and import flows in the remarkably detailed Harmonized System product classification.[4]

The Customs Statistics dataset contains the annual export and import traffic of the firms, both in value (forints and U.S. dollars) and in tons, so we are able to calculate unit value measures. We use unit value as a proxy for price. The traffic is divided into product categories broken down to 6-digit Harmonized System (HS) level. In addition, we observe whether the shipment originated in (or went to) one of the 15 countries of the pre-2004 European Union (EU15). Other than that, we do not have information on the partner countries.

The sample consists of 2,043 large exporting companies which exported more than 100 million HUF in any of the years. These were further broken down into two categories: domestic (less than 33% foreign ownership) and foreign-owned firms (foreign ownership exceeds 33%). Table 1 displays how these firms are represented in each of the years of this unbalanced panel. The average spell in the sample is 5.38 years for domestic and 6.52 years for foreign firms.[5] During this decade, one of the most important developments in Hungary was the growing number and market share of foreign firms.

4. There are more than 5,000 product categories at the 6-digit level.

5. Note that some firms change ownership status during the sample. This typically means a domestic firm being bought by foreign investors. Hence the relatively short spell of domestic firms.

The median firm has 151 employees, the employment average is 339, which shows a somewhat declining trend. This hides a marked decline in the size of the average domestic firm and a rise for the average foreign firm. (See Table 2.) Note, however, that the separate employment trend of foreign firms is entirely due to composition effects: firms bought by foreigners tend to be bigger. When restricting the sample to a balanced panel of firms, we see no clear trend in the average firm size.

Based on the Broad Economic Classification (BEC) of products, we restricted our sample to products that are most likely to be intermediate inputs, namely primary and processed industrial supplies (BEC 21 and 22), primary and primary and processed fuels (BEC 31 and 32), capital good components (BEC 42) and transport equipment components (BEC 53). We hence excluded food, consumer products, transport equipment and capital goods from the analysis. This resulted in 2,764 products.

Firms in our sample cover the bulk of Hungarian exports, ranging from 47% in 1992 to a top of 76% in 1999 (see Table 3). We have data on exports for each firm from two sources: their financial statement and disaggregated customs statistics. The correlation between these two measures across firms is reassuringly high: 0.953. Foreign firms are more export oriented for obvious reasons. (See Table 5b.) The export orientation of the average Hungarian firm increased substantially over the sample period. There are three channels through which this took place: firms already in the sample increased their market share, entered new product markets, and new, more export oriented firms entered the sample.

As Table 4a documents, the average firm had positive imports in 59 different HS6 categories. Foreign firms imported more than twice as many products (81) as domestic ones (36). This is also true within the sample restricted to "intermediate products." In line with this finding, foreign firms relied more on imported intermediate inputs in production; their share in total material costs was 70% on average, while that of domestic firms was 37% on average, both with an increasing trend (Table 4b). Interestingly, the trend in imports is primarily due to an increase in the number of imported products for foreign firms (increasing from 57 to 97 during the 10 years), while there is no trend of "import diversification" for domestic firms.

Looking at exported products in Table 5a, domestic firms exported 14 products on average, as compared to 19 by foreign firms. During this period, foreign firms almost tripled the number of products exported, while that has not changed so

much for domestic ones. The increasing external orientation of foreign firms is also present if we look at the balanced sample of firms over the 10 years. That is, the pattern is not driven by firm entry, exit or change of ownership. This implies that foreign firms preferred widening the commodity composition of their export supply by adding new products to the product line rather than increasing their market share in existing ones.

Our dataset permits to give a broad assessment of intra-industry trade at the firm level. The average number of products which were both exported and imported by the same firm increased from 5.0 to 14.5 (Table 5c). This increase was mainly due to foreign firms as their measure of "intra-good trade" almost quadrupled over the period, but it also increased substantially for domestic firms. (This remains true for the balanced sample, as well.) One potential reason for the large intra-good trade is the increasing fragmentation of production and the increase in processing trade, which involves subsidiaries of multinational companies reexporting the product after some labor-intensive processing. One caveat of our dataset is that we have no information about the trading partner, which would allow to infer intra-firm trade.[6] Nonetheless, the explanation of processing trade is consistent with the variation of import prices we document later.

Relative import prices vary quite substantially even within 6-digit HS categories in any given year. Table 6 reports the standard deviation of log unit values within a 6-digit category for various aggregate product categories. In the full sample, the within-product standard deviation is 1.37, with technology-intensive products displaying a higher price dispersion. Nevertheless, even seemingly homogeneous products such as meat and vegetable products, foodstuff, and minerals command a widely dispersed unit value. This suggests that there is substantial product heterogeneity within HS categories, probably due to quality differences.[7] Overall, 14% of the within-product variation is explained by firm×year fixed effects, that is, this fraction is attributable to firm-specific shocks to prices. In contrast, market-specific (EU vs non-EU) year dummies account for only 6% of the variation. Not surprisingly, the importance of firm-specific factors is higher for differentiated products, whereas market factors are more important for rela-

6. See Hanson et al. (2003) for recent evidence on the extent of within-firm trade.

7. Even crude oil prices vary substantially with grade.

tively homogeneous products. This variation will prove useful in our identification strategy.

3.1. SPECIFICATIONS

We use our predictions on import demand elasticity to test for the presence of buyer-specific markups. For low enough markups, $\ln[1/(1-1/\sigma_k)] \approx 1/\sigma_k$, the markup pricing rule (1) can be loglinearly approximated as

$$p_k \approx \frac{1}{\sigma_k} + c, \tag{3}$$

that is, log import price is the sum of the inverse elasticity of demand and log marginal cost. We will hence treat the log import price as the dependent variable. Substituting in the elasticity of input demand from (2),

$$p_k = 1/\theta + s_{ik}(1/\phi - 1/\theta) - \beta_k s_{ik}/\mu_k\phi + c. \tag{4}$$

The log import price of product i sold in year t to firm k will be

$$p_{ikt} = \alpha_i + \nu_t + \gamma_1 s_{ikt} + \gamma_2 \beta_{kt} s_{ikt} + \gamma_3 m_{kt} + \gamma_4 x_{ikt} + \gamma_5 \mathbf{z}_{kt} + u_{ikt}. \tag{5}$$

Here α_i is a product, ν_t is a year fixed effect, m_{kt} is a proxy for output markup of firm k in year t, x_{ikt} is the firm's share in the total Hungarian imports of good i, $\mathbf{z}_{kt}$ is a vector of firm-level controls (firm size, dummy for foreign ownerships), and u_{ikt} is an idiosyncratic error term representing unobserved heterogeneity in marginal cost (c).

We expect γ_1 to be positive as inputs with bigger share among intermediates tend to have less elastic demand. On the other hand, γ_2 should be negative, since inputs with higher share in total cost significantly affect the marginal cost of production, thereby having a more elastic demand. Higher output markups should lead to higher input prices, $\gamma_3 > 0$, as less competitive firms are more inert in the input markets, too. According to a nonlinear pricing story, γ_4 would be negative, that is, firms buying more of a certain product would face lower per-unit prices. Two clarifications are in order. First, we distinguish the share of input in the firms material costs (s_{ikt}) and the share of the firm in total imports of the given good (x_{ikt}), as the two measures have different economic interpretations, and affect the import price differently. Second, we do not include the quantities purchased directly, as this is probably highly (negatively) correlated with unobserved errors

in the import price. We use the value-weighted share in total Hungarian imports instead.

As proxies of market power in output markets, we include two measures:

(i) the firm's export unit value relative to the Hungarian average, averaged across products,

(ii) the ratio of sales to labor and material costs.

A caveat of using the relative export price as a regressor is that it is likely to be endogenous. We expect that unmeasured quality differences in the import product also affect the price at which the export products can be sold, raising an issue of reverse causality. Furthermore, given the big variations in relative prices, the relative export price is likely to suffer from a measurement error. Therefore, to judge the causal impact of export prices on import prices, we use an instrumental variables technique. We instrument the relative export price with

(i) a Herfindahl-Hirschman Index (HHI) of concentration of Hungarian firms exporting the same products as the firm,

(ii) the average share of total Hungarian exports in the EU imports of the given products.

These instruments are correlated with the firm's markup in its European export market but are unlikely to be correlated with firm-specific errors in import prices.[8]

Even at this disaggregate level, product categories may arguably contain products of very heterogenous quality and price. We take account of unobserved quality heterogeneity in the following way. We estimate our model on a group of homogeneous products, as well, where product differentiation and buyer-specific markups do not exist.[9] Hence any correlation with firm-specific observables can only be

8. Note that the story of reverse causality from higher-than-average import prices to higher-than-average export prices relies on the *cost* raising effect of import prices, whereas our IV strategy identifies the *markup*, not the cost. Nonetheless, we cannot exclude that markups and production costs are correlated, though it is unclear why this correlation should be positive. In future research, we intend to analyze the complex choice firms make about their production technology, the quality (and cost) of their inputs and their market power in more detail.

9. These products are homogeneous in the sense that they are not differentiated and are sold in competitive markets. Within any product *category*, however, there will be a heterogeneous group of these products.

due to cost heterogeneity. This enables us to judge the validity of our identifying assumption that the marginal cost of imports is uncorrelated with the buying firm's technology and market power. The group of differentiated products includes processed industrial supplies (BEC 22), capital good components (BEC 42) and transport equipment components (BEC 53). Homogeneous products comprise of primary industrial supplies (BEC 21), and primary and processed fuels (BEC 31, 32).

4. Results

The first part of Table 7 contains the results of pooled OLS regressions. Columns 1 and 2 contain regression for differentiated products. As predicted by our model of PTF, products having a higher share in intermediate costs trade at a higher price, whereas share in total costs lowers the price. Both measures of markup have a highly significant and large impact on the import price: a firm with 10% higher markup pays $1.0 - 1.4\%$ more for its imports. Market power in the import market (share of Hungarian imports going to the firm) has a large negative effect on import prices.

Columns 3 and 4 contain the same specification for the control group of homogeneous products. We see that cost shares and the markup is unrelated to import price. A higher export price, on the other hand, is associated with a higher import price, suggesting that there is within-product *cost heterogeneity* even for homogeneous goods. Nonetheless, column 4 confirms our identification assumption that buyer markups are uncorrelated with the cost of imported products. Note that the within-group variation of import unit values is not significantly smaller for homogeneous products, indicating a large role for unobserved cost heterogeneity. What is important, though, is that this heterogeneity is orthogonal to our explanatory variables.

Among the additional control variables, we see that size and foreign ownership increase the import price, though (as expected) this effect is less significant for homogeneous products. Interestingly, if the firm both exports and imports the "same" product, it tends to pay a lower price, especially for differentiated products. This is consistent with a story of *processing trade*: these firms buy the product at a lower grade (hence cheaper) to re-export it after some labor-intensive processing.

Colums 5 through 8 of Table 7 contain the instrumental variables (IV) estimates, where both measures of markup are instrumented with the Herfindahl-Hirschman concentration index of Hungarian exporting firms and their overall share in the EU. The predictions of PTF remain true in this specification, too. More importantly, once export prices and markups are instrumented, we do not see any impact of cost shares and markups on the import prices of homogeneous products, that is, these are indeed uncorrelated with cost differentials. The control variables remain robust in the IV specification.

As documented earlier, foreign firms are more external oriented than domestic firms. We are therefore interested in whether import prices behave differently in these two subgroups. Tables 8 and 9 contain regression results for domestic and foreign firms, respectively. In general, the coefficients are very robust across the two subsamples, suggesting that PTF is prevalent for both domestic- and foreign-owned firms.

A notable difference is that the import price of domestic firms is almost twice as sensitive to their import market power as that of foreign firms. That is, a percentage point increase in the import market share of a domestic firm lowers its import price by $0.7 - 0.8\%$, while this number is only $0.4 - 0.5\%$ for foreign firms. One explanation is that small domestic firms are more vulnerable than small foreign firms. In all other respects (technology parameters, the impact of markup, intraindustry trade), the two groups are remarkably similar.

5. Conclusion

We documented that the import price of a particular product varies substantially across Hungarian manufacturing firms. Importantly, we can relate the level of import prices to firm characteristics such as size, foreign ownership and market power. We developed a theory of "pricing to firm" (PTF), where markups depend on the technology and competitive environment of the buyer because they affect the elasticity of input demand.

We distinguish two concepts of market power with very different consequences. On the one hand, the share of the firm in the import market lowers the import price (buyers of bigger quantities face lower prices) either because of non-linear pricing schemes or due to their higher bargaining power. On the other hand, firms

with big market power in their export market face higher input prices because their price sensitivity is lower.

The predictions of the model are confirmed by the data: import prices are higher for firms with greater output market power, especially for intermediate inputs with a high share in total costs, and lower for firms with a bigger share in Hungarian imports. We take account of the endogeneity of the buyer's market power and the unobserved quality heterogeneity within product categories. As expected, PTF is prevalent for foreign firms and differentiated products.

Traditional international macro models usually assume either perfect competition (marginal cost pricing) or product differentiation by the seller with monopolistic competition. None of these frameworks is capable of explaining the rich patterns we see in import price data. First, neither predicts price dispersion across buyers unless there are differences in the marginal cost. Given the sheer magnitude of price dispersion and its variation with buyer characteristics, it is unlikely to be generated by cost differences alone. Second, quality differences (an inherent feature of import markets) are not necessarily reflected in prices. Because sellers charge a constant markup, any improvement in the quality (marginal product) of a given input will solely benefit the buyer. In reality, however, buyers and sellers may share the surpluses of better quality through a higher price. In future research, we also wish to investigate the determinants of this quality-price relationship.

Given that PTF is so important in explaining import prices, we see further avenues for research in this area. First, we may need to rethink a number of questions about relative prices in international macro, such as the exchange rate pass-through debate or the real exchange rate debate. Recently, Imbs, Mumtaz, Ravn and Rey (2003) demonstrated how aggregation conceals important time-series properties of relative prices (e.g., fairly quick mean reversal in the case of deviation from PPP). We believe that the firm-level analysis can contribute to these debates.

Second, we may also learn new insights about the prevalence of intra-industry trade by looking at why firms both buy and sell the same products. This potentially relates to research on within-firm trade (Hanson et al. 2003) and strategic issues of multinational companies, such as transfer pricing (Halpern and Koren 2003).

References

Antràs, P. and Helpman, E. (2003). Global sourcing, Working paper. Harvard University.

Egan, M. L. and Mody, A. (1992). Buyer-seller links in export development, *World Development* **20**(3): 321–334.

Gereffi, G. (1999). International trade and industrial upgrading in the apparel commodity chain, *Journal of International Economics* **48**: 37–70.

Grossman, G. M. and Helpman, E. (2003). Outsourcing in a global economy, Working paper. Harvard University.

Halpern, L. and Koren, M. (2003). Export pricing of foreign firms in Hungary: Estimations for 1992-96, *CEPR Discussion Paper* **3833**.

Hanson, G. H., Mataloni, R. J. and Slaughter, M. J. (2003). Vertical production networks in multinational firms, *NBER Working Paper* **9723**.

Helpman, E. (1999). The structure of foreign trade, *Journal of Economic Perspectives* **13**(2): 121–144.

Hummels, D., Ishii, J. and Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade, *Journal of International Economics* **54**(1): 75–96.

Imbs, J., Mumtaz, H., Ravn, M. O. and Rey, H. (2003). PPP strikes back: Aggregation and the real exchange rate, *CEPR Discussion Paper* **3715**.

McLaren, J. (1999). Supplier relations and the market context: A theory of handshakes, *Journal of International Economics* **48**: 121–138.

Rauch, J. E. (1999). Networks versus markets in international trade, *Journal of International Economics* **48**: 7–35.

A. Data Appendix

The definitions of variables used are below. The source(s) for each variable is given in brackets.

Import price: The c.i.f. unit value (HUF/ton) of total import shipments to the firm in a given year in a given 6-digit HS category. [Customs Statistics]

Foreign ownership: A firm is considered foreign-owned (dummy=1) if foreign ownership exceeds 33% of equity and regarded domestic otherwise. [Balance Sheet]

Employment: Average annual employment. [Balance Sheet]

Share of good among intermediates: The total HUF value of import shipment of the good divided by total material cost. [Customs Statistics, Financial Statement]

Share of good in total costs: The total HUF value of import shipment of the good divided by total cost. [Customs Statistics, Financial Statement]

Relative export price: The f.o.b. export unit value of the good relative to the average EU unit value. [Customs Statistics, EuroStat]

Average relative export price: The relative export price averaged across all the products exported by the firm. [Customs Statistics, EuroStat]

Import share: The share of the firm in the HUF value of total Hungarian imports of the given product in the given year. [Customs Statistics]

Export HHI: The export Herfindahl–Hirschman Index of product k in year t is constructed from the firms' share in total Hungarian exports as $\text{HHI}_{kt} = \sum_i (X_{ikt}/X_{\text{HU},kt})^2$. [Customs Statistics, Hungarian Statistical Office]

Differentiated product: Product classified as processed industrial supplies, capital and transport equipment components are called *differentiated* while primary supplies and fuels are *homogeneous*. [Broad Economic Categories]

Table 1
Firms in the sample

Year	Domestic	Foreign	Total
1992	504	387	891
1993	584	528	1,112
1994	645	614	1,259
1995	653	675	1,328
1996	701	762	1,463
1997	745	828	1,573
1998	746	878	1,624
1999	725	834	1,559
2000	729	800	1,529
2001	689	795	1,484
Total	1,249	1,089	2,043
Average spell (years)	5.38	6.52	6.77

Table 2
Average size of firms

Year	Domestic	Foreign	Total
1992	734	267	531
1993	510	273	397
1994	436	260	350
1995	395	273	333
1996	354	281	316
1997	308	307	308
1998	294	324	310
1999	267	348	311
2000	261	368	317
2001	258	363	314
Total	367	312	339

Table 3
Sample coverage

Year	Share in total Hungarian Exports	Imports
1992	47%	31%
1993	57%	31%
1994	58%	37%
1995	67%	45%
1996	69%	53%
1997	75%	58%
1998	74%	60%
1999	76%	62%
2000	66%	56%
2001	72%	57%

Table 4a
Number of imported products

Year	Domestic	Foreign	Total
1992	38.5	57.1	46.6
1993	33.4	59.6	45.8
1994	33.7	66.8	49.9
1995	34.4	70.3	52.6
1996	34.7	76.9	56.7
1997	35.6	81.8	59.9
1998	38.0	87.7	64.8
1999	36.3	93.8	67.1
2000	39.8	96.9	69.7
2001	37.1	97.0	69.2
Total	36.2	81.4	59.4

Table 4b
Share of imported inputs

Year	Domestic	Foreign	Total
1992	24%	51%	31%
1993	26%	43%	33%
1994	29%	50%	39%
1995	36%	47%	42%
1996	39%	63%	53%
1997	34%	68%	58%
1998	44%	73%	67%
1999	48%	76%	71%
2000	42%	81%	73%
2001	35%	67%	62%
Total	37%	70%	61%

Table 5a
Number of exported products

Year	Domestic	Foreign	Total
1992	14.0	10.1	12.3
1993	11.9	10.2	11.1
1994	12.0	11.6	11.8
1995	13.0	13.8	13.4
1996	13.1	17.2	15.2
1997	13.1	18.5	15.9
1998	13.9	20.7	17.6
1999	14.1	22.9	18.8
2000	15.5	25.3	20.6
2001	16.1	28.5	22.7
Total	13.7	18.9	16.4

Table 5b
Share of export sales

Year	Domestic	Foreign	Total
1992	32%	30%	31%
1993	30%	29%	30%
1994	29%	35%	31%
1995	30%	44%	37%
1996	28%	52%	42%
1997	36%	53%	49%
1998	38%	58%	54%
1999	35%	62%	57%
2000	36%	61%	56%
2001	39%	61%	57%
Total	34%	57%	51%

Table 5c
Number of products both exported and imported

Year	Domestic	Foreign	Total
1992	4.8	5.4	5.0
1993	4.4	5.5	4.9
1994	4.5	6.6	5.5
1995	5.5	8.1	6.8
1996	5.4	10.5	8.1
1997	5.5	11.7	8.8
1998	6.5	13.9	10.5
1999	6.3	16.0	11.5
2000	7.3	18.2	13.0
2001	7.9	20.2	14.5
Total	5.9	12.4	9.2

Table 6
Within-product price dispersion

Product category	Price dispersion	Market specific shocks	Firm specific shocks
Section I: Animal Products	0.832	13%	0%
Section II: Vegetable Products	0.882	12%	0%
Section III: Animal or Vegetable Fats	0.970	16%	0%
Section IV: Prepared Foodstuff, Beverages, Tobacco	0.907	11%	1%
Section V: Mineral Products	1.293	5%	5%
Section VI: Chemicals	1.188	9%	8%
Section VII: Plastics	1.305	6%	12%
Section VIII: Leather and Products	1.144	10%	12%
Section IX: Wood and Products	1.282	2%	11%
Section X: Paper and Products	1.391	5%	6%
Section XI: Textile and Apparel	1.013	11%	11%
Section XII: Footwear	1.070	13%	6%
Section XIII: Stone and Glass	1.400	2%	14%
Section XIV: Jewellery	1.556	5%	14%
Section XV: Metals	1.377	5%	15%
Section XVI: Machinery	1.547	4%	17%
Section XVII: Vehicles	1.338	5%	17%
Section XVIII: Instruments	1.553	4%	15%
Section XIX: Arms and Ammunition	1.119	3%	6%
Section XX: Miscellaneous	1.390	7%	17%
Section XXI: Works of Art	1.377	0%	45%
Total	1.374	6%	14%

Table 7

Determinants of import price (pooled sample)

	OLS estimates				IV estimates			
	Differentiated		Homogeneous		Differentiated		Homogeneous	
	1	2	3	4	5	6	7	8
Share in intermediates	0.5180 ***	0.5195 ***	– 0.5821	– 0.4449	0.3927 ***	0.1415	– 0.5661	0.2613
	(0.0404)	(0.0405)	(0.6961)	(0.6980)	(0.0420)	(0.0946)	(0.7069)	(0.9746)
Share in costs	– 0.5184 ***	– 0.5167 ***	1.1809	1.0049	– 0.4413 ***	– 0.2595 **	1.1604	0.3045
	(0.0681)	(0.0683)	(0.8672)	(0.8695)	(0.0698)	(0.0905)	(0.8813)	(1.1447)
Average relative export price	0.1366 ***		0.1541 ***		0.5463 ***		0.1363	
	(0.0026)		(0.0185)		(0.0249)		(0.1368)	
Markup		0.0961 ***		0.0094		0.9962 ***		– 2.8541
		(0.0063)		(0.0437)		(0.2028)		(2.1769)
Share in HU imports	– 0.6049 ***	– 0.6146 ***	– 0.2516 **	– 0.2577 **	– 0.5637 ***	– 0.5767 ***	– 0.2523 **	– 0.1830
	(0.0237)	(0.0237)	(0.0817)	(0.0819)	(0.0243)	(0.0256)	(0.0819)	(0.1111)
Origin: EU15	– 0.0950 ***	– 0.1052 ***	0.0956 **	0.0864 **	– 0.0673 ***	– 0.1145 ***	0.0945 **	0.1548 *
	(0.0046)	(0.0046)	(0.0303)	(0.0304)	(0.0050)	(0.0052)	(0.0313)	(0.0629)
Foreign firm	0.0190 ***	0.0156 ***	0.0808 **	0.0857 **	0.0006	– 0.0734 ***	0.0815 **	0.4199
	(0.0041)	(0.0042)	(0.0287)	(0.0292)	(0.0043)	(0.0205)	(0.0292)	(0.2562)
Employment (log)	0.1091 ***	0.1155 ***	0.0224 *	0.0305 **	0.0939 ***	0.1274 ***	0.0233	– 0.0160
	(0.0014)	(0.0014)	(0.0097)	(0.0097)	(0.0017)	(0.0030)	(0.0120)	(0.0371)
Exports same product	– 0.2938 ***	– 0.2862 ***	– 0.1419 **	– 0.1304 **	– 0.3142 ***	– 0.2785 ***	– 0.1406 **	– 0.1035
	(0.0050)	(0.0051)	(0.0448)	(0.0449)	(0.0053)	(0.0054)	(0.0460)	(0.0562)
Observations	561,085	561,085	12,231	12,231	561,085	561,085	12,231	12,231
Product FEs	2,523	2,523	241	241	2,523	2,523	241	241
Year FEs	10	10	10	10	10	10	10	10
R-squared	0.02	0.02	0.01	0.01				
Sigma(log Pi)	1.3796	1.3796	1.3761	1.3761	1.3796	1.3796	1.3761	1.3761

Notes: Dependent variable is log import unit value. Standard errors are in parantheses. Significance at 5, 1, and 0.1% is denoted by *,**,***, respectively. Constant and fixed effects not reported. Sigma(log Pi) denotes the within-product standard deviation of log import price. In colums 5 through 8 measures of markup are instrumented with a HHI concentration index of Hungarian exporting firms and Hungarian share in EU imports for the given products. See Data Appendix for variable definitions.

Table 8

Determinants of import price (domestic firms)

	OLS estimates				IV estimates			
	Differentiated		Homogeneous		Differentiated		Homogeneous	
	1	2	3	4	5	6	7	8
Share in intermediates	0.7679 ***	0.7135 ***	– 1.2415	– 1.0206	0.6122 ***	– 0.2257	– 0.6353	– 1.1277
	(0.0733)	(0.0737)	(1.9006)	(1.8942)	(0.0769)	(0.1981)	(1.9743)	(2.0960)
Share in costs	– 0.5907 ***	– 0.5371 ***	1.9782	1.7319	– 0.4945 ***	0.2091	1.2237	1.7201
	(0.1280)	(0.1284)	(2.4799)	(2.4718)	(0.1313)	(0.1994)	(2.5705)	(2.7301)
Average relative export price	0.1436 ***		0.1010 **		0.5268 ***		– 0.2056	
	(0.0044)		(0.0312)		(0.0433)		(0.2222)	
Markup		0.3057 ***		0.7358 ***		2.8507 ***		– 2.9884
		(0.0158)		(0.1321)		(0.4926)		(4.3824)
Share in HU imports	– 0.8157 ***	– 0.8423 ***	– 0.0061	0.0037	– 0.7351 ***	– 0.8126 ***	0.0003	– 0.0353
	(0.0433)	(0.0433)	(0.1340)	(0.1336)	(0.0451)	(0.0468)	(0.1358)	(0.1545)
Origin: EU15	– 0.0112	– 0.0137	0.2347 ***	0.2253 ***	0.0040	0.0127	0.2204 ***	0.2491 ***
	(0.0079)	(0.0079)	(0.0488)	(0.0486)	(0.0083)	(0.0099)	(0.0505)	(0.0605)
Employment (log)	0.0737 ***	0.0884 ***	0.0236	0.0336	0.0552 ***	0.1522 ***	0.0414	0.0128
	(0.0026)	(0.0026)	(0.0179)	(0.0178)	(0.0033)	(0.0127)	(0.0222)	(0.0314)
Exports same product	– 0.2575 ***	– 0.2538 ***	0.0383	– 0.0470	– 0.2743 ***	– 0.2754 ***	0.0091	– 0.0460
	(0.0090)	(0.0090)	(0.0776)	(0.0774)	(0.0094)	(0.0105)	(0.0814)	(0.1389)
Observations	176,460	176,460	3,826	3,826	176,460	176,460	3,826	3,826
Product FEs	2,370	2,370	198	198	2,370	2,370	198	198
Year FEs	10	10	10	10	10	10	10	10
R-squared	0.02	0.02	0.01	0.02				

Notes: Dependent variable is log import unit value. Standard errors are in parantheses. Significance at 5, 1, and 0.1% is denoted by *,**,***, respectively. Constant and fixed effects not reported. In colums 5 through 8 measures of markup are instrumented with a HHI concentration index of Hungarian exporting firms and Hungarian share in EU imports for the given products. See Data Appendix for variable definitions.

Table 9
Determinants of import price (foreign firms)

	OLS estimates				IV estimates			
	Differentiated		Homogeneous		Differentiated		Homogeneous	
	1	2	3	4	5	6	7	8
Share in intermediates	0.4233 ***	0.4301 ***	– 0.4720	– 0.3115	0.3095 ***	– 0.2512 *	– 0.5004	0.4646
	(0.0486)	(0.0487)	(0.7846)	(0.7873)	(0.0504)	(0.1205)	(0.7981)	(1.1321)
Share in costs	– 0.5118 ***	– 0.5136 ***	0.8995	0.6947	– 0.4453 ***	– 0.0615	0.9368	– 0.0844
	(0.0810)	(0.0812)	(0.9569)	(0.9600)	(0.0832)	(0.1125)	(0.9759)	(1.3010)
Average relative export price	0.1307 ***		0.1751 ***		0.5767 ***		0.2104	
	(0.0032)		(0.0228)		(0.0305)		(0.1824)	
Markup		0.0597 ***		– 0.0639		1.5880 ***		– 2.5793
		(0.0069)		(0.0471)		(0.2441)		(2.1643)
Share in HU imports	– 0.4898 ***	– 0.4915 ***	– 0.3524 **	– 0.3601 ***	– 0.4708 ***	– 0.3926 ***	– 0.3504 **	– 0.2634
	(0.0292)	(0.0293)	(0.1076)	(0.1080)	(0.0300)	(0.0349)	(0.1081)	(0.1505)
Origin: EU15	– 0.1374 ***	– 0.1495 ***	– 0.0169	– 0.0267	– 0.1006 ***	– 0.1817 ***	– 0.0145	0.0539 ***
	(0.0057)	(0.0057)	(0.0385)	(0.0386)	(0.0063)	(0.0079)	(0.0404)	(0.0826)
Employment (log)	0.1224 ***	0.1274 ***	0.0202	0.0281 *	0.1068 ***	0.1395 ***	0.0183	– 0.0260
	(0.0017)	(0.0017)	(0.0121)	(0.0121)	(0.0021)	(0.0027)	(0.0154)	(0.0486)
Exports same product	– 0.3125 ***	– 0.3050 ***	– 0.1486 **	– 0.1343 *	– 0.3347 ***	– 0.2797 ***	– 0.1514 **	– 0.1135
	(0.0061)	(0.0061)	(0.0559)	(0.0561)	(0.0065)	(0.0077)	(0.0577)	(0.0676)
Observations	384,625	384,625	8,405	8,405	384,625	384,625	8,405	8,405
Product FEs	2,459	2,459	213	213	2,459	2,459	213	213
Year FEs	10	10	10	10	10	10	10	10
R-squared	0.03	0.02	0.02	0.01				

Notes: Dependent variable is log import unit value. Standard errors are in parantheses. Significance at 5, 1, and 0.1% is denoted by *,**,***, respectively. Constant and fixed effects not reported. In colums 5 through 8 measures of markup are instrumented with a HHI concentration index of Hungarian exporting firms and Hungarian share in EU imports for the given products. See Data Appendix for variable definitions.