The Nature of Outsourcing Relationships: Evidence from OAP Prices.

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Deborah L. Swenson*
UC Davis and NBER

Abstract:

This paper studies the extent and variation in pass-through for U.S. outsourcing imports. Data on 4,676 products imported through the U.S. overseas assembly program (OAP) show that outsourcing imports were characterized by incomplete pass-through of production and trade costs to import prices. Notably, pass-through was higher for products assembled in high education countries while the response of outsourcing import prices to competing suppliers' prices was largest for products sold by firms in capital-intense industries. The reasons for these cross-country and cross-industry differences, as they relate to theories of outsourcing and trade, are explored.

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* Contact Information: Department of Economics, One Shields Avenue, University of California, Davis, CA 95616. Email: dswenson@ucdavis.edu. Phone: (530) 752-0741.

Introduction

The dramatic growth in international outsourcing has fueled the expansion of international trade and deepened international integration.[1] Developments in outsourcing attract public attention due to concern that improvements in information technologies enable companies to relocate production or assembly activities to lower-cost overseas locations.[2] However, while international outsourcing allows firms to take advantage of factor price differences, Grossman and Helpman (2005) demonstrate that country cost differences are not sufficient by themselves to guarantee outsourcing, since international outsourcing decisions are based on many factors including the costs of search and customization.

More generally, new research in international trade recognizes information as a key element in the globalization process. However, informational improvements, such as reduced communication costs or increasingly sophisticated bar code transmission and management tools may not affect all producers uniformly. As Rauch and Trindade (2003) show, product differentiation in consumption or production, when combined with informational uncertainty, produces a degree of "natural protection". For this reason information technology improvements are likely to deliver the greatest increases in global integration for those markets where the matching of differentiated partners is critical to the formation of new international partnerships.

[1] Hummels, Ishii and Yi (2001) show that vertical specialization accounted for 30% of export growth between 1970 and 1990. Feenstra (1998) and Spencer (2005) provide reviews of outsourcing trends and theories. Related work of Hanson, Mataloni and Slaughter (2005), Gorg (2000), Egger and Egger (2005) and Swenson (2005a) studies the empirical determinants of outsourcing choices.

[2] Amiti and Wei (2005) show that the presumption of outsourcing job loss may be reversed if one also accounts for job gains associated with international "insourcing". Further, Grossman and Rossi-Hansberg (2008) demonstrate that outsourcing of low-skilled tasks may even increase compensation earned by low-skilled workers in the home country. Finally, Chongvilaivan, Hur and Riyanto's (2009) study of 2002 U.S. data finds a positive connection between downstream outsourcing and the earnings of U.S. skilled workers.

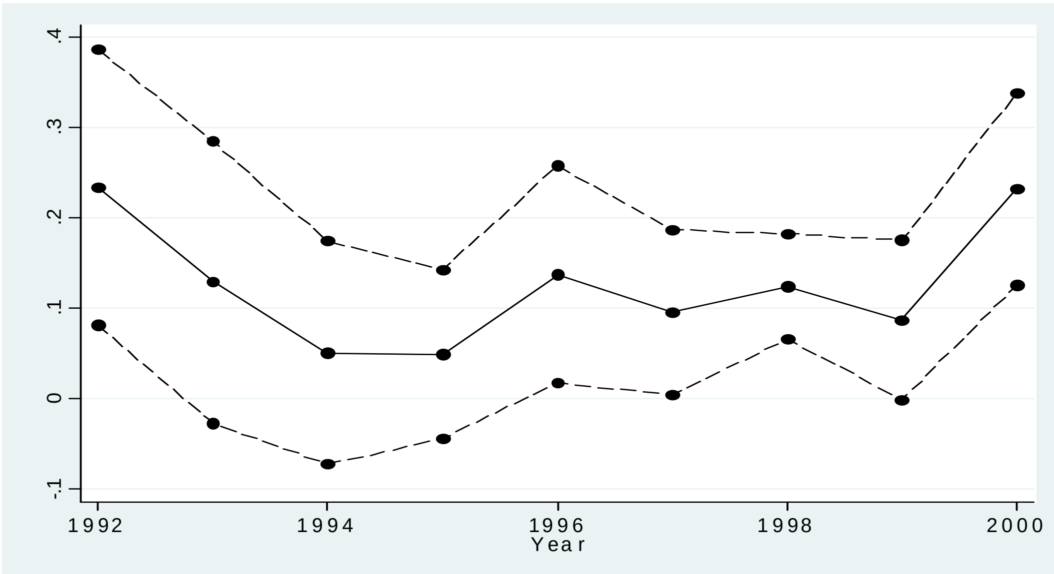
A key goal of this paper is to study whether outsourcing decisions are consistent with outsourcing models that feature search and adaptation costs. To this end, this paper studies U.S. outsourcing conducted under the auspices of the overseas assembly program, or OAP. While, OAP does not include all U.S. outsourcing activities – it does not capture U.S. assembly of foreign parts, or overseas contract manufacturing that is based on U.S. designs and specifications – OAP imports provide insight into a wide swath of U.S. outsourcing and represented 8.5 percent of U.S. import value during the sample period.

Since OAP administration involves the collection of detailed information on outsourcing transactions, OAP import data facilitate the precise measurement of cost shocks and trade frictions at the country-product level. In particular, heterogeneity in input choices both across countries and products can be exploited to identify pass-through and general price responses for outsourcing imports. For example, year by year pass-through can be estimated by regressing yearly OAP price changes at the product-country level on product-country cost changes. Plots of the year by year coefficients in Figure 1 show that the raw rate of OAP pass-through ranged from six to 23 percent.[3] However, accurate outsourcing pass-through estimation requires a theory-based estimation framework that controls for economic factors that also influence price decisions.

This paper adopts Feenstra's (1989) pass-through model, which is modified to account for the cost structure and tariff treatment facing outsourcing firms who produced products for import under the OAP. This framework, which is based on a Bertrand model of competition in internationally differentiated goods, focuses its attention on cost pass-through and on the degree to which producers emulate the price changes of their competitors.

[3] The cost measure is the total cost constructed according to equation (1) from section 3 of the paper.

Figure 1: OAP Outsourcing Pass-Through, based on year to year changes.



Notes: The points on the solid line are the coefficients from yearly regressions of country-product outsourcing price changes on the change in country-product cost. The dashed lines represent the 95% confidence interval.

Examination of U.S. OAP outsourcing imports reveals that twenty to forty percent of changes in production costs are passed through to product prices. More notably, the degree of production cost pass-through differs across country suppliers: the pass-through is highest for products assembled in countries that have more highly and likely more diversely, educated workforces. Industry capital-intensity is also positively related to the degree of production cost pass-through. Finally transportation and tariff costs are generally passed-through at a higher rate than assembly costs, suggesting that the rate of pass-through is higher for costs that are commonly borne by all producers than is the rate of pass-through applied when firms face idiosyncratic firm-specific cost changes.

The prices chosen by producers of U.S. OAP imports also respond to the prices selected by competing assemblers in other countries. However, while full sample results indicate that outsourcing firms increase their prices by two to four percent when their competitors increase their prices by ten percent, the responsiveness to competitor prices is especially high for producers in capital-intense industries. Thus, if search and adaptation costs are correlated with industry capital-intensity, this evidence supports theories in which differential costs of locating and adapting to potential outsourcing partners leads to differential outsourcing trade elasticities.

By showing how outsourcing price responses differ with industry capital or skill-intensity, and with country education levels, this paper contributes to our understanding of the factors that help shape outsourcing decisions. These findings also contribute to the growing literature that demonstrates how industry or country characteristics affect international trade outcomes.[4] The rest of the paper is structured as follows. To provide an overview of the outsourcing relationships examined in this paper Section 2 describes OAP outsourcing characteristics. Section 3 provides a model of pricing, and the associated regression framework. It also develops detailed cost measures which are based on the procedural features of the OAP. Empirical analysis in section four quantifies how production costs, trade costs and competitor prices affected the OAP import prices. It also examines the importance industry and country characteristics for these responses and discusses their economic implications. The paper ends with a brief conclusion.

[4] When Besedes and Prusa (2006) examine U.S. trade transactions, their evidence that trade transactions "start small" supports Rauch and Watson's (2003) theoretical work which is based on informational uncertainty. Other work studies trade patterns to determine whether country institutional quality influences comparative advantage. Levchenko (2007) finds that better institutions enable countries to produce more complex goods, while countries with better contract protections 1) specialize in goods that require relationship-specific investment [Nunn (2007)], and 2) produce more complex goods [Costinot (2009)].

2. Outsourcing in the Overseas Assembly Program

This paper utilizes data from the US Overseas Assembly Program as a means of gaining insight into the nature of pricing decisions in outsourcing transactions.[5] A key benefit of examining OAP outsourcing is that OAP import data provide detailed information on outsourcing relationships which are reported country by country at the product level. During the sample period, the U.S. imported 4,676 distinct 8-digit HS (HS8) products through the OAP.[6]

Table 1 displays information on the country composition of OAP import transactions. The majority of OAP outsourcing involves the assembly of U.S. parts in a developing country. If member countries of the OECD are classified as developed, 81 percent of the transactions in the data set involve developing country assembly. Alternatively, if countries that averaged six or more years of education are classified as developed, 63 percent of the observations involve developing country assembly.

The data in Table 1 suggests that geographical proximity influences OAP participation. Canada and Mexico were the most frequent participants, registering 3,518 and 7,940 unique (HS8 product)-year transactions each. In contrast, distant countries participate less frequently. The importance of geographical proximity is not surprising, as firms using the OAP ship their U.S. inputs, not only from the assembly country to the U.S. in the final good, but also from the U.S. to the overseas location for assembly.[7]

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[5] The OAP, which is codified under section 9802 of the current tariff code, grants tariff privileges to U.S. import products for their use of U.S.-origin parts, components or materials.

[6] HS8 examples: Microwave ovens (85165000), Instrument panel clocks for vehicles, spacecraft or vessels (9104000), Food grinders, processors and mixers (85094000), footwear with outer soles of leather covering the ankle, on a base or platform of wood, not having an inner sole or protective metal toe-cap (64035111).

[7] In addition to direct costs of transportation, Hummels (2007) and Evans and Harrigan (2005) provide evidence on the time costs of international distance.

The HS2 industry composition of overseas assembly is displayed in Table 2. When the data are sorted by the value of U.S. inputs included in the OAP products, the top three OAP industries were electrical machinery (85), transportation equipment (87), and apparel and clothing, not knitted or crocheted (62).[8] For each HS2 industry, the table also lists the identity of the primary country supplier, where the *primary supplier* is defined as the country that shipped the largest total value of OAP products in that HS2 category. The influence of geographical proximity on the location of outsourcing is also evident here. Of the 30 largest OAP industries, either Mexico or Canada was the prime location for nineteen. However, more distant countries were primary suppliers in some industries: Malaysia for footwear (64), Hong Kong for imitation jewelry (71), and Switzerland for clocks and watches (91), suggesting that outsourcing assembly decisions also reflect traditional sources of comparative advantage.

To characterize production methods, Table 2 reports the *U.S. percentage*, defined as the percentage of total product value attributable to U.S. parts and materials. Since U.S. inputs are exempt from tariff, OAP administration requires firms to separately report product value derived from dutiable foreign inputs and assembly, and from U.S.-origin parts and components. Thus, OAP records enable one to observe the relative reliance on U.S. and foreign inputs at a product-country level. Over the 1991-2000 sample the average U.S. percentage was 36 percent, while the average foreign percentage was 64 percent.

Figure 2 illustrates the dramatic variation in production techniques across countries. This box-whisker plot displays the average percentage foreign content for the 27 countries that were the most frequent OAP participants. Each country has many foreign

[8] These are followed by, non-electrical machinery (84), apparel and clothing, knitted or crocheted (61), Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus (90), Aircraft and spacecraft (88), and footwear (64).

content observations, since each of the countries shipped a wide range of OAP outsourcing products to the U.S. Thus, for each thick shaded box, the left, dividing and right points for each country's box represent the foreign content percentages observed for each country's assembly operations at the 25th, 50th and 75th percentiles.

Figure 2: Cross-Country Differences in Production Techniques

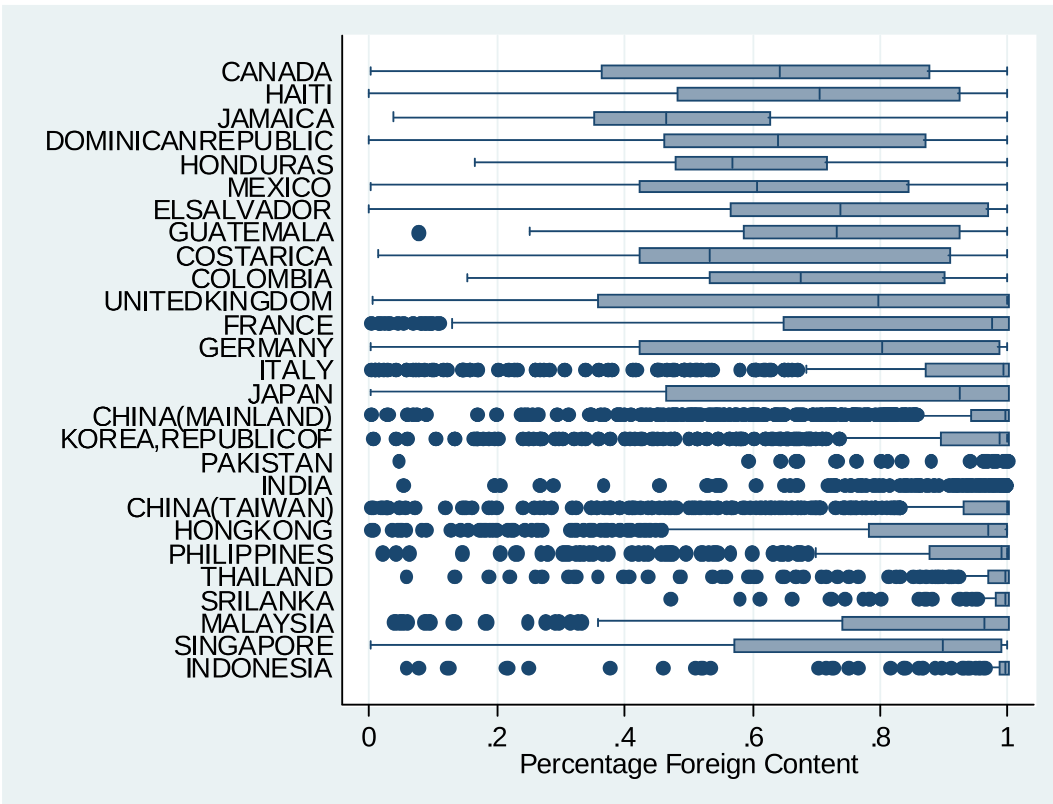
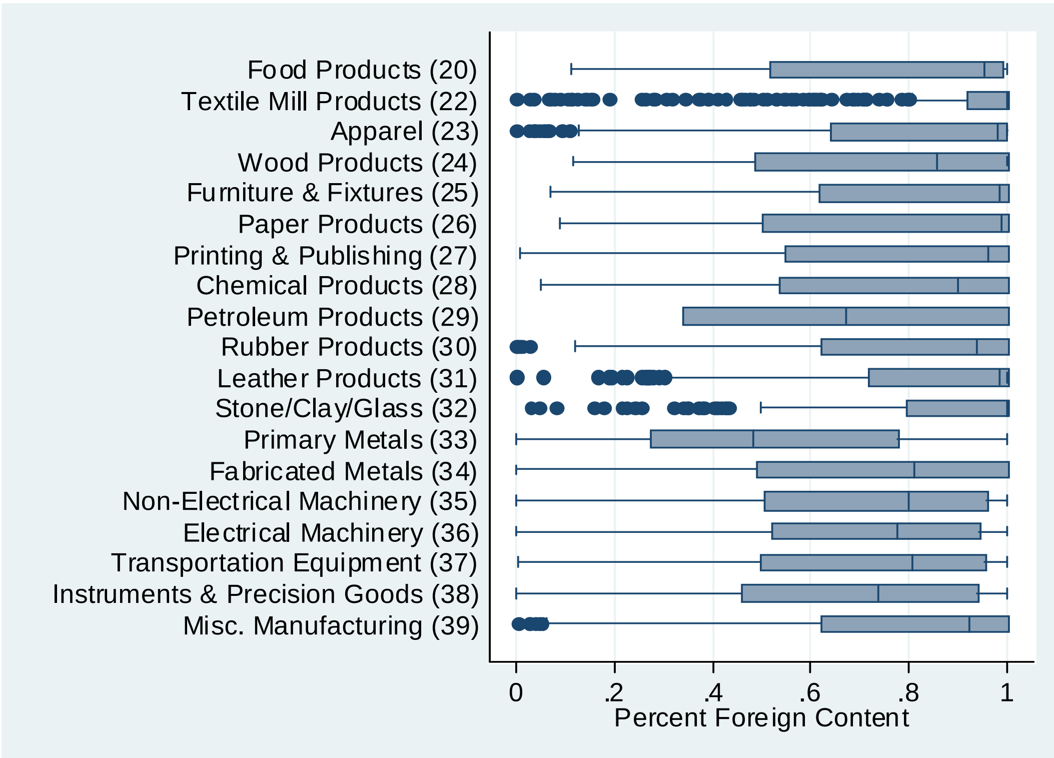


Figure 2 orders countries according to their distance from the U.S.; countries at the top of the figure are closer to the U.S. In general, Figure 2 shows that more distant assembly countries use a higher percentage of foreign content than do assembly countries near the U.S. Nonetheless, country-level cost shocks will generate very different effects for different outsourcing products assembled within each country, since for each country, input choices vary considerably across products. With only a few exceptions, the difference in the foreign content between a country's products at the 25th percentile versus the country's products at the 75th percentile exceeded 20 percentage points.

Figure 3: Cross-Industry Differences in Production Techniques



For an alternative perspective on production differences within industries, Figure 3 displays a box-whisker plot of foreign content percentages for OAP imports organized by 2-digit SIC industry. Each SIC industry has multiple observations, since many HS8 products are contained in each 2-digit industry, and because most those products were assembled in more than one country. The figure emphasizes the enormous within-industry differences in outsourcing operations, as with only two industry exceptions the foreign content for assembly operations at the 25th percentile was 20 percentage points lower than the use of foreign content for the industry's products at the 75th .

Due to cross-country and cross-product variation in production techniques, it is possible to construct detailed cost measures that vary uniquely at the product-country level. For example, consider a set of outsourcing products assembled in China, each characterized by the percentage U.S. and foreign content in its production. When Chinese production costs rise, cost increases will be especially pronounced for those products with the highest percentage of their production located in China. A heavy reliance on Chinese inputs also proves costly in product sectors that face the highest U.S. import tariffs. In contrast, products characterized by a high percentage of Chinese-origin inputs will benefit from lower transportation costs since there is less back and forth shipment of U.S.-origin parts and material. Naturally, products which contain a high share of Chinese content are also relatively advantaged when the cost of U.S. inputs rises.

3. A model of pricing decisions

This section introduces outsourcing cost measures that account for the unique input and tariff structure of imports shipped through the OAP. Next, a Bertrand model of competition in internationally differentiated goods is modified to relate OAP import prices to a firm's outsourcing costs and the pricing decisions of its competitors, and to test whether variation in price responses support economic theories of outsourcing based on information and matching.

3.1 Production

Following Mendez (1993), OAP assembly is modeled as a Leontieff production process.[9] When OAP producers assemble product i in country c, they combine a fixed

[9] While Swenson (2005b) finds that relative production costs and tariffs influence OAP input choices, the tiny economic magnitude of these input responses support the suitability the Leontieff assumption.

bundle of U.S. inputs with a fixed bundle of foreign inputs and assembly. To characterize input bundles, I assume that OAP assembly involves a set of tasks on the unit interval that must be completed in an ordered succession. Thus, a firm's decision to participate in OAP indicates that the U.S. has comparative advantage in the early stage tasks, while the foreign country has comparative advantage in later tasks and assembly. If β_{ic} denotes the point on the unit interval at which U.S. processing ends and foreign production begins, and each task requires physical inputs M_i, then $\beta_{ic}*M_i$ is the U.S. input requirement while the foreign input requirement is $(1- \beta_{ic})* M_i$. If the cost of U.S. inputs is w_{us}, the U.S. dollar price of foreign inputs is w_c, and inputs are transported to the foreign assembler at ad valorem cost g_{ic}, assembly of product i in country c has cost:

(1) $C_{ic} = [\beta_{ic}*w_{us}* (1+g_{ic}) + (1- \beta_{ic})*w_c]*M_i$.

When OAP products are shipped from the assembly country to the U.S. two further costs arise. First, the appropriate U.S. import tariff τ_i is applied to the foreign portion of product value, $(1- \beta_{ic})*w_c*M_i$. In addition, the transportation of the completed product to the U.S. incurs the ad valorem shipping cost g_{ic}.

OAP import assembly costs will differ across locations for a number of reasons, including differences in production techniques that cause the Leontieff input choices to vary across locations as dictated by skills, endowments and production costs. In addition, while time subscripts are excluded for notational simplicity, overseas assembly costs will also fluctuate over time as wages, transport costs and tariffs change.

3.2 Demand

To model pricing decisions, I assume that product market competition is Bertrand. Each country produces a unique variety of the outsourced good, which is an imperfect substitute for products from other countries. Thus, a producer of a particular good faces product demand $q_{ic} = d(P_{ic}^{C}, P_{ic}^{C\sim}, E_i)$, where each product's demand is negatively related to the producer's own choice of consumer price P_{ic}^{C}, and positively related to the price vector of its competitor consumer prices $P_{ic}^{C\sim}$ and to overall expenditure E_i on product i.

Using $\alpha_{us,ic}$, the U.S. share of product value that is exempt from tariff, the relationship between the consumer and producer (P_{ic}^{P}) price is given by:[10]

(3) $P_{ic}^{C} = [P_{ic}^{P} *(1+g_{ic}) + (1-\alpha_{us,ic})* P_{ic}^{P} * \tau_i]$.

This can be rearranged to yield,

(3') $P_{ic}^{P} = P_{ic}^{C} * [(1+g_{ic}) + (1-\alpha_{us,ic})* \tau_i]^{-1}$.

Firms now choose P_{ic}^{P} to maximize profits:

(4) $\pi = P_{ic}^{C} * [(1+g_{ic}) + (1-\alpha_{us,ic})* \tau_i]^{-1}* d(P_{ic}^{C}, P_{ic}^{C\sim}, E_i) - C_{ic}*d(P_{ic}^{C}, P_{ic}^{C\sim}, E_i)$,

which generates the familiar first order condition:

(5) $P_{ic}^{C} (1+ 1/ \eta_i) = [(1+g_{ic}) + (1-\alpha_{us,ic})* \tau_i]*C_{ic}$.

Prices are determined by a markup over marginal cost. The markup is determined by the elasticity of demand (η_i) for product i. The marginal cost has two components: trade costs are given by $[(1+g_{ic}) + (1-\alpha_{us,ic})* \tau_i]$, while marginal production costs are represented by C_{ic}. For estimation, we use Feenstra's (1989) reduced form, as in (6).

(6) $P_{ic}^{C} = \Gamma [\{(1+g_{ic}) + (1-\alpha_{us,ic})* \tau_i \}*C_{ic}), P^{\sim}_{ic}, E_i]$

Restoring time subscripts and adopting a log-linear form generates the familiar pass-through regression equation:

(7) $\ln P_{ict}^{C} = \alpha + \beta_1 \ln([(1+g_{ict}) + (1-\alpha_{us,ic})* \tau_{it}]) + \beta_2 \ln(C_{ict}) + \gamma \ln(P^{\sim}_{ict}) + \delta \ln E_{it} + \varepsilon_{ict}$

However, this equation needs to be modified since recent work on import prices demonstrates that cross country differences in quality are present even when trade data

[10] The U.S.-origin contribution to product value is: $\alpha_{us,ic} = [\beta_{ic}*w_{us}* (1+g_{ic})]/[\beta_{ic}*w_{us}* (1+g_{ic}) + (1- \beta_{ic})*w_c]$.

are disaggregated to the fine product level.[11] To account for unobserved differences in product quality that are correlated with country development I add a measure of country development D_c to the basic specification. This yields the primary estimating equation that is used to analyze the prices of outsourcing imports.

(7') $\ln P_{ict}^{C} = \alpha + \beta_1 \ln([(1+g_{ict}) + (1-\alpha_{us,ic})^* \tau_{it}]) + \beta_2 \ln(C_{ict}) + \gamma \ln(P^{\sim}_{ict}) + \delta \ln E_{it} + \lambda \ln D_c + \varepsilon_{ict}$

As in the pass-through literature, the coefficients on trade costs and production costs, β_1 and β_2, are both expected to be in the interval [0,1], which run the gamut from no pass-through of cost changes to complete pass-through of any changes in cost.[12] In addition, the coefficients on competitor prices γ, country development λ, and expenditure δ are all expected to be positive.

3.3 Heterogeneous Product Responses

The main estimating equation assumes that pass-through and market reactions are the same for all products. However, this assumption fails if market characteristics affect the degree of product market competition. For example, differential product elasticities are a feature of Rauch and Trindade's (2003) matching model in which the elasticity of substitution between internationally differentiated product varieties increases with improved information, since better information enables firms to rule out unacceptably poor matches before conducting international partner searches. While Rauch and Trindade explore the implications of information for the creation of international joint ventures, information-based matching frictions may similarly influence outsourcing trade

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[11] See Hummels and Klenow (2005), Schott (2003, 2004) and Hallak (2006).
[12] See Goldberg and Knetter (1997) for a thorough discussion of the literature on pass-through.

relationships, with information uncertainty reducing outsourcing trade elasticities the most for those products where information uncertainty is the greatest.

Cross-country differences in search and adaption costs may reinforce the prediction of differential pricing responses for different outsourcing relationships. In particular, Grossman and Helpman (2005) demonstrate that Northern firms may seek partners in the high-wage North, if the costs of search and adaptation in the South are sufficiently high as to inhibit the entry of potential partners in the South. In addition, since the resulting thinness of partners in the South reduces the probability of a successful match, it further reduces the incentive to search for partners in the low-wage South. In a multiple country setting with wage shocks, these ideas suggest that an increase in the relative wage of one country will spur a greater degree of outsourcing relocation in industries characterized by the lowest search and modification costs.

Since there are no straightforward measures of search costs or uncertainty by industry, I assume the costs of search and modification, as well as search uncertainty, are highest for technologically sophisticated industries and for partner searches in more highly skilled countries. Search and adaptation costs are likely to be especially high in sophisticated industries, for example, since these industries are likely to involve a large set of search criteria whose presence is difficult to verify. To examine whether pricing decisions respond in a fashion that is consistent with the notion of costly or uncertain search, I add capital-intensity [K_i] interaction terms to the regression.[13]

$$(8)\quad \ln P_{ict}^{C} = \alpha + (\beta_1 + \beta_{1K}*\ln(K_i))*\ln([(1+g_{ict})+ (1-\alpha_{us,ic})* \tau_{it}])+ (\beta_2 + \beta_{2K}*\ln(K_i))*\ln(C_{ict}) + (\gamma + \gamma_K*\ln(K_i))*\ln(\tilde{P}_{ict}) + \delta\ln E_{it} + \theta*\ln(K_i) +\lambda\ln D_c + \varepsilon_{ict}$$

[13] Specification (8) may also be motivated by work on the organizational form of international production. A notable contribution in this area is Antras's (2003) work demonstrating how greater reliance on intra-firm trade transactions can emerge to solve contracting problems in capital-intense industries.

Naturally, industry capital-intensity is only one transaction characteristic that affects search and modification costs. Another way to represent matching costs is to use education as a measure of skill. While primary education generally focuses on a relatively common set of reading and math skills, higher education is likely to generate more heterogeneous skill outcomes across countries.[14] When a firm seeks more highly skilled workers, its managers are likely to face a more difficult search, since their criteria are no longer based on a minimum education, but on identifying workers who possess training in particular skills and methods. To account for this possibility I also investigate the effects of including interaction terms based on country education, HE_c.

$$(9)\quad \ln P_{ict}^{C} = \alpha_{ic} + (\beta_1 + \beta_{1HE}*HE_c)*\ln([(1+g_{ict}) + (1-\alpha_{us,ic})*\tau_{it}]) + (\beta_2 + \beta_{2HE}*HE_c)*\ln(C_{ict}) + (\gamma + \gamma_{HE}*HE_c)*\ln(\tilde{P}_{ict}) + \delta \ln E_{it} + \lambda HE_c + \varepsilon_{ict}$$

4. Results

Analysis of OAP outsourcing data supports predictions from a Bertrand model of competition, as OAP import prices are positively related to production and trade costs, as well as competitor prices. Further, price responses vary with industry capital-intensity and country education in a fashion that supports search cost theories of outsourcing.

4.1 Data

To measure pass-through in outsourcing transactions, the dependent variable is country-HS8 product import prices for OAP import transactions between 1991 and 2000, as measured by unit values. OAP import transaction prices are also used to measure

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[14] Examples of heterogeneity at higher education levels include wide differences in the skills of college educated workers who choose not only majors, but subspecialties, or differences in the capabilities of highly skilled technicians who have received training in particular techniques and procedures.

competitor prices $P^{\sim}$, which are defined as the average import price for competing country producers in the same HS8 product and year.

Research on pass-through typically focuses on a single product, such as passenger automobiles. In such projects, it is feasible to use country-specific producer price indices to measure local costs. In contrast, since this project involves almost 5,000 products and 100 countries, no comprehensive producer cost data correspond to the country-product disaggregation of the data set. For this reason, the Penn World Table country-level price indices are used for w_c and w_{us} when constructing the cost measure according to equation (1). One benefit of these data is that they encompass the price of a wide range of inputs (labor, materials, energy) that are involved in the assembly process. More importantly, since OAP outsourcing is often conducted in countries where wage data is sparse, absent, or poorly measured, this measure maximizes the observations that can be included in the sample.[15] Fortunately, as illustrated in the figures in section two, the production cost variable gains abundant country-industry variation due to wide country-product differences in input choices. Further time series country-product cost variation is generated by changes in transportation costs which vary over time, and are specific to country-product pairs. The data appendix provides a fuller discussion of the data set, including the sources for the remaining variables used in the analysis.

4.2 Estimation

Table 3 presents benchmark estimates of regression (7'). The coefficients uniformly show that OAP import prices were positively related to production costs, with

[15] To check for robustness, I ran regressions with a UNIDO wage-based cost measure, for countries that have wage data. The results were qualitatively similar, which was not surprising, as the correlation between wages and the price deflators used in this paper is 0.62.

an implied pass-through of ten to forty percent. The regressions also show that trade costs were incompletely passed through. In each specification the pass-through of trade costs was somewhat greater than the pass-through of production costs.[16] The greater pass through of trade costs suggests that firms pass-through common cost changes to a greater extent than they pass-through idiosyncratic cost changes.[17]

The results in Table 3 also reveal a strong positive relationship between the prices charged by OAP assemblers and the prices charged by their competitors. The OLS estimates imply that assemblers incorporated forty percent of competitor price changes in their own prices, while the panel estimates in columns (2), (3) and (4) imply that OAP producers mimicked twenty-five percent of their competitors' price changes.

Similar to Schott (2003, 2004), Hummels and Klenow (2005), and Hallak (2006), OAP import prices are positively related to country development. This association holds whether development is captured by membership in the OECD, country education, or the log of country per capita income. The only coefficient that changes in magnitude as the definition of development changes, is the production cost coefficient, which rises in magnitude when development is measured by country education, and falls when country development is measured by per capita GDP. Since per-capita GDP is highly correlated with wages, and hence, country costs, the coefficient on per-capita GDP picks up some of the effects of production costs, thus causing the estimated coefficient on the production cost term to fall in size. In contrast, when country development is measured by the country education variable, the apparent pass-through of production costs rises. This

[16] The difference between pass-through of producer costs versus transportation and tariff costs is statistically distinct, though in column (3), the results are only statistically distinct at the 6% level.

[17] Gron and Swenson (2000) find a similar phenomenon in U.S. car prices, while Besanko, Dranove, and Shanley (2001) provide empirical evidence showing that firms pass-through common shocks to a greater degree than they pass through idiosyncratic cost shocks.

result is sensible, since accounting for country education helps to control for differences in country costs that are related to otherwise unmeasured differences in worker quality.

To look for evidence of search cost effects in outsourcing decisions I assume the difficulty and cost of finding a new outsourcing partner is highest for products that require complex and highly specified production skills, and that capital-intensity is a proxy for such complexity.[18] However, before turning to the full interaction specification (8), I first examine whether capital-intensity has a direct influence on OAP import prices.[19] The results in the first three columns of table 4 confirm that industry capital-intensity was highly correlated with OAP import unit values. In addition, the results show that the magnitude of the effect of industry capital-intensity on import prices differs for developed and developing assembly. Finally, adding capital-intensity as a regressor leads to a small rise in the estimated value of production cost pass-through.

The one coefficient that becomes unstable when industry capital-intensity is added to the regression is the coefficient measuring trade cost pass-through. This may be due to the underlying correlation between industry capital-intensity and tariff rates, which are a component of trade costs.[20] Thus, when capital-intensity is directly included in the estimating equation, the capital-intensity term may pick up some of the variation related to tariff costs, consequently changing the apparent magnitude of the trade cost pass-through.

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[18] Some high capital industries may have low search costs, if capital replaces skilled labor. However, if capital intensity is positively correlated with technical sophistication *on average*, the effects will operate as predicted.

[19] The number of observations declines since it is not possible to map all HS 8 codes to a 1987-value SIC code, which is required to connect the product data to industry variables.

[20] U.S. tariffs are higher in less capital-intense industries. For the industries and years in the sample, regression of an industry's tariff rate on the industry's capital-intensity and time yields:

$\text{Tariff Rate}_{it} = .185(.015) - .031(.001)*\ln(\text{average KY})_i - .0016(.0002)*\text{year}.$

Next, to search for indirect evidence on the influence of industry capital-intensity, I estimated interaction specification (8), and reported the results in columns (4) and (5) of Table 3. The positive coefficient on the interaction between industry capital-intensity and competitor prices suggest that the tendency to mimic competitor price increases was positively related to industry capital-intensity. Thus, if capital-intensity increases search uncertainty, or search costs, then producers in those industries may have felt confident that they could match their competitors' price increases without losing their assembly work to assemblers in other countries.

The effects of search or switching costs may also be magnified by "market thickness" externalities if they influence the number of potential suppliers. To search for evidence supporting this possibility, the count of country competitors was regressed on measures of industry capital-intensity.[21] As the following table shows, there were indeed fewer competing source countries for OAP producers in capital-intense industries.

The Effect of Capital-intensity on the Number of Countries Providing Products: Negative Binomial Regressions			
		Independent Variable	
Specification	**Dependent Variable**	$\ln(\text{Average KY})_i$	$\ln(KY)_{it}$
(1)	Count of Competitors 1991-2000	-1.033 (.038)	
(2)	Count of OECD Competitors 1991-2000	-.690 (.083)	
(3)	Count of Non-OECD Competitors 1991-2000	-6.478 (.329)	
(4)	Number of Countries Supplying HS8 product in year 1991-1996		-.287 (.060)

Note: Standard error in ( ).

[21] "Competitors" is the count of countries that provided a particular HS8 product for at least one of the years between 1991 and 2000.

To further explore how capital-intensity affected the population of OAP competitors, I created separate competitor counts for OECD and non-OECD suppliers. This distinction makes sense if developed countries were better suited for some assembly tasks, while developing countries were better suited for others.[22] When competitor counts are defined by OECD membership, as shown in rows (2) and (3), the negative association between competitor counts and industry capital intensity is found to be especially strong for OAP assembly imports from developing countries. This could mean that assembly operations in non-OECD locations were better substitutes for each other, than were assembly operations in OECD locations. Alternatively, if OECD countries were more heavily engaged in skill-intense activities characterized by high search and adaptation costs, they may have faced less risk of displacement following production costs changes and fluctuations.

Since the capital-intensity data are only available through 1996 it is not feasible to track the connection between yearly changes in capital-intensity and changes in competitor counts for the entire sample period. However, examination of the time-series data for 1991-1996 in specification (4), shows that the number of countries providing overseas assembly declined in those U.S. industries that became more capital-intense.

The fact that fewer countries competed in OAP assembly activities in capital-intense industries may explain why firms in more capital-intense industries were more likely to match their competitor's price changes. If producers in capital-intense industries raised their prices, the greater difficulties and requirements involved in successfully switching partners may have insulated them from displacement by competitors from

[22] In related work, Blonigen and Davies (2004) and Blonigen and Wang (2005) note that factors influencing the receipt of foreign investment differ for developing and developed countries.

other countries. Alternatively, the correlation may have arisen from the market power that comes with a larger market share. Since Feenstra, Gagnon and Knetter's (1996) find that exchange rate pass-through was higher for auto producers who had larger market shares, it would be interesting to test whether their market share model explains OAP pricing decisions. Unfortunately, the lack of U.S. industry production data for each of the HS8 products precludes the creation of appropriate market share terms.[23]

An alternative way to look for evidence that industry matching matters is to include industry skill-intensity rather than capital-intensity in the regressions. Table 5 does this by examining whether industry skill requirements affected product prices or price sensitivity. To measure industry skill intensity, I defined the skilled-wage percentage at the industry level as [non-production worker wages]$_i$/[Total wages]$_i$. Columns (1) and (2) examine the direct effects of including skill measures in the regressions. Coefficients on the skill measures show that OAP import prices were higher in industries characterized by a relatively high skilled wage percentage. In addition, import prices were higher for products assembled in countries with more highly educated workforces. The positive and significant coefficient on assembly country education suggests that more highly educated countries produced higher quality varieties of the HS8 goods, or varieties of the goods that were more differentiated and thus could command higher markups due to a lower elasticity of demand.

The cost of searching for outsourcing assembly partners may be highest in countries with highly educated workforces, if a country's skill diversity rises with

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[23] Nonetheless, the data in this sample reveal a high correlation between capital-intensity and OAP market share, defined as a country's share of OAP product exports in a given industry. OLS regression of a country's average industry market share on the industry's capital-intensity and a set of country dummies yields: Average Market Share$_{ic}$ = .216(.006)*ln(average KY)$_i$ + $\sum C_C$. Estimation with panel techniques and random effects for country-industry pairs yields: Market Share$_{ict}$ = 177(.006)*ln(KY)$_{it}$ + ε_{ict}, which demonstrates, that country market shares rose as the capital-intensity of the U.S. industry increased.

country education. In addition, the cost of search may be especially high when firms seek highly skilled workers who are more skill-differentiated than low-skilled workers. To test whether skill specificity and complexity affect outsourcing relationships, I assume that the most skilled and specialized searches arise when a skill-intensive industry searches for employees in a highly educated country. To test this idea, columns (3) and (4) of Table 5 add an interaction between the industry skilled wage percentage with an indicator denoting whether the country was highly educated. The strong positive coefficient on the interaction term shows that import prices were particularly high when a skilled industry product was produced in a more highly educated country.

Finally, I estimated interaction equation (9) to determine whether country education levels affected price responses. The results show that country education levels influenced assembler ability to pass-through production costs changes. Column (6) of Table 5 suggests that assemblers located in low education countries passed-through only thirty percent of their production costs changes. In contrast, producers located in highly educated countries were able to pass-through 97 percent of their production cost changes.

To test the robustness of greater pass-through for outsourcing products assembled in high education locations, I replaced the indicator variable for highly educated countries with the actual educational attainment for each country's adult population aged 25 or over. The new results reported in Table 6 echo the findings shown in Table 5. This includes a strong positive association between outsourcing import prices, and the interaction regressor multiplying educational attainment by industry skill intensity.[24] More important, the results confirm the discovery that production cost pass-through and country education are positively related. The coefficient estimates in column (6) imply

[24] The indicator variables HE_c in equation (9) is replaced with HE_c*ln(Education)$_{c}$.

that the median education country could pass-through 25% of its cost changes, while countries in the top 25%, by education, could pass-through 94% of their production cost changes.

Use of a direct schooling measure also allows one examine whether an additional year of schooling provided a greater boost to the product value of high or low education countries. The results in column (4) show that extra education was especially valuable to producers in more educated locations. While a 10% increase in educational attainment for countries whose attainment was less than 6 years, implied a 3.5% increase in product prices, a 10% increase in educational attainment was associated with a 7.5% increase in product prices for countries in the high education group.

4.3 Robustness Checks

A number of checks were run to verify the robustness of the results. Each case employs the same estimating equation as that reported in column (2) of Table 3.

First, to learn whether there was significant heterogeneity in pass-through across industries, regressions were run for each of the HS2 industries individually. However, while estimation at the HS2 industry level reveals heterogeneity in the extent of production cost pass-through, the median value for the HS2 production cost coefficients is 0.229, which is very similar to the result for the pooled sample. Next, since textiles and footwear are believed to be among the most footloose industries, I also estimated the pass-through equation for this group of products, HS2 industries 61 through 64. However, the production cost pass-through for this group of industries is 0.158, and is not statistically distinct from the full sample value of 0.200.

A second question is whether the absence of comprehensive and internationally comparable measures of production costs creates large problems with measurement error. For the sample between 1991-1996, it is possible to replace the general U.S. price measure used in the creation of the production cost measure with 4-digit SIC U.S. price deflators from Bartlesman, Becker and Gray. However, when I run the regression for those years with the original cost measure, and the modified cost measure, the coefficients on the production cost terms are 0.253(.048) and 0.339(.047), respectively. Consequently, measurement error in the cost term does not appear to affect the results dramatically.

Robustness checks were also run to evaluate whether the degree of production cost pass-through declined over time. However, there is no evidence of such a decline. In particular, if equation (8) is implemented with interaction terms based on the variable year, the insignificance of time interaction terms suggests that there was no particular time trend in the pass through of production costs.

Another question is whether the availability of alternative trade programs, such as the NAFTA, affected the results.[25] The presence of alternative trade programs is problematic if there was a correlation between pricing behavior, and the identity of those producers who decided to enter their U.S. imports through NAFTA rather than the OAP. Thus, to check whether NAFTA participation decisions affected the results, I estimated the pricing equation without observations for OAP imports from Mexico or Canada. In their absence, the estimated production cost pass-through coefficient is 0.259(.003), which is again very similar to the full sample estimate. Therefore, this suggests that there

[25] Even after NAFTA was in force, provisions regarding the general custom's user's fee continued to benefit OAP participants. In addition, many U.S. tariffs on Mexican imports were non-zero during the sample period, since they were undergoing the phase-in process.

were no systematic differences in the pricing behavior of firms that would need to be accounted for if some firms left the OAP to use NAFTA trade channels instead.

Finally, I experimented with changes in the expenditure term. However, while the current results are all based on yearly HS8 expenditure measures, use of HS4 or HS6 expenditure variables does not change any of the coefficients of interest.

5. Conclusion

This paper studies the pass-through of production and trade costs in OAP outsourcing transactions. In this setting, a number of regularities are observed. First, production cost pass-through ranges from 20 to 40 percent in the full sample. More notably, the results show that outsourcing price responses are related to industry and country characteristics. For example, production cost pass-through is highest for outsourcing assemblers located in countries with more highly educated workforces. While a median education country could pass-through 25% of its cost changes, countries with education in the top 25% could pass-through 94% of their production cost changes.

Thomas's Friedman's book, *The World is Flat*, has shaped the view that international trade, and outsourcing in particular, contribute to a draconian environment in which firms and workers must match the prices or wages of their lowest cost competitors if they wish to survive. However, while OAP data show that commonly borne costs, such as transportation and tariff costs are passed-through at a higher rate than are idiosyncratic country-product costs, the data suggest that the world is not perfectly flat: in a completely flat, perfect competition world, there would be no pass-through of firm-specific costs. Further, the finding that OAP producers emulate only 20 to 40 of their competitors' price changes, further contradicts the notion of a perfectly flat world.

To the extent that responses to competitor prices are heterogeneous, the results show that OAP producers in capital-intense industries are more likely to match their competitor's price changes. Since capital-intense industries or industries requiring greater worker skills and education are likely to entail higher search costs due to their relative complexity and sophistication, these heterogeneous price responses are consistent with outsourcing models such as Grossman and Helpman (2005) where differences in search or adaptation costs influence outsourcing decisions. In addition, the fact that OAP competitor presence was lowest in capital-intense industries suggests that search costs related to capital-intensity may also affect the substitution between country suppliers through their effect on competitor presence.

Since some industry and country characteristics appear to insulate outsourcing producers from perfect competition, it would be interesting to learn more about the specific mechanisms. For example, in the case of capital-intensity, are the differences in price responses due to the effects of high fixed costs on competitor entry, or due to the presence of technological sophistication and expertise that are difficult to imitate? Alternatively, in the case of education, do OAP prices rise with country education because more highly educated countries have better workers who produce higher quality varieties of the goods, or because education improves a country's innovation capabilities, thus supporting the creation of product varieties that are more differentiated from their nearest competitors?[26]

[26] See Khandewal (2010) for empirical evidence on quality differentiation and competition, including the evidence that quality differentiation helps to insulate U.S. industries from low wage country competition.

Table 1: OAP Outsourcing Activities, 1991-2000					
MEXICO	7940	VIETNAM	284	MAURITIUS	45
CANADA	3518	NICARAGUA	225	URUGUAY	44
CHINA	2993	BANGLADESH	219	BOLIVIA	41
DOMINICAN REPUBLIC	2434	TURKEY	212	MONACO	40
HONGKONG	2103	BARBADOS	191	THE CZECH REPUBLIC	38
KOREA	1698	NETHERLANDS	190	BELARUS	38
TAIWAN	1686	BRAZIL	190	GREECE	34
INDIA	1602	SWITZERLAND	188	FINLAND	33
COSTARICA	1580	IRELAND	169	NORWAY	33
COLOMBIA	1535	POLAND	155	NEW ZEALAND	32
GUATEMALA	1498	TRINIDAD AND TOBAGO	150	MONTSERRAT	31
ELSALVADOR	1437	PERU	136	VENEZUELA	30
PHILIPPINES	1326	PORTUGAL	126	LITHUANIA	29
JAPAN	1270	BELGIUM	123	OMAN	25
HONDURAS	1230	SPAIN	115	SLOVENIA	24
HAITI	1140	SWEDEN	109	SLOVAKIA	23
ITALY	1057	RUSSIA	101	DOMINICA	21
JAMAICA	718	AUSTRALIA	100	TUNISIA	20
UNITED KINGDOM	700	EGYPT	100	MALDIVE ISLANDS	19
THAILAND	649	UKRAINE	98	LESOTHO	18
GERMANY	595	PANAMA	98	MACEDONIA	17
INDONESIA	559	AUSTRIA	96	UZBEKISTAN	16
MALAYSIA	530	ST.VINCENT	95	BURMA	15
PAKISTAN	503	NETHERLANDS ANTILLES	95	MALTA	15
SRILANKA	503	ROMANIA	83	ARGENTINA	14
SINGAPORE	483	BELIZE	70	CROATIA	13
FRANCE	463	UNITED ARAB EMIRATES	65	SIERRA LEONE	11
MACAO	349	ISRAEL	64	KENYA	11
ST. LUCIA	327	DENMARK	59	QATAR	11
ECUADOR	318	MOROCCO	54	SOUTH AFRICA	11
ST.KITTS NEVIS	312	CHILE	50	PARAGUAY	10
GUYANA	302	BULGARIA	47	MOZAMBIQUE	10
HUNGARY	300	NEPAL	46	GRENADA	10

The table displays the number of distinct HS8 product-year observations of OAP unit import values that are available for each country.

Table 2: OAP Sourcing Activity by 2-digit HS Industry, 1993									
HS2	Total Value of OAP Imports ($mill)	U.S.-origin Value of OAP Imports ($mill)	U.S. %	Largest Source Country	HS2	Total Value of OAP Imports ($mill)	U.S.-origin Value of OAP Imports ($mill)	U.S. %	Largest Source Country
85	14,255	6,910	48.5	Canada	91	98	30	31.1	Switzerland
87	27,879	3,660	13.1	Canada	86	64	27	43.1	Canada
62	3,840	2,131	55.5	Peru	48	36	19	51.2	Canada
84	4,303	1,236	28.7	Canada	65	28	16	56.6	Canada
61	1,331	977	73.4	Mexico	82	40	15	37.6	Taiwan
90	1,503	674	44.8	Canada	59	41	15	37.0	Canada
88	712	299	42.0	Canada	92	105	15	12.1	Japan
76	274	218	79.7	Canada	40	18	13	69.0	Mexico
64	1,135	194	17.1	Malaysia	89	84	12	12.0	Canada
29	155	149	95.8	France	70	23	10	40.4	Canada
63	204	124	61.0	Peru	44	21	9	44.2	Canada
94	191	107	56.0	Canada	58	11	9	39.2	India
72	160	105	65.7	United Kingdom	49	10	4	43.8	Mexico
73	268	97	36.3	Canada	69	16	4	25.7	Mexico
83	109	77	70.8	Mexico	56	5	4	67.3	Mexico
95	143	70	49.1	Mexico	93	15	4	20.8	Japan
39	114	69	60.9	Canada	30	8	3	33.8	Germany
71	72	61	85.6	Hong Kong	28	5	3	49.8	Germany
37	116	58	50.3	Netherlands	54	2	2	77.8	China
74	63	48	76.6	Canada	36	4	2	39.3	Mexico
42	106	46	43.9	Mexico	81	3	2	57.9	Germany
96	65	34	53.7	China	68	2	1	68.0	Italy

Notes: Largest Source Country denotes the country which had the largest total value shipped through the OAP. U.S. % is computed for each HS2 category as, 100*[US Value of OAP Imports]/ [Total Value of OAP Imports].

Table 3: The Effect of Costs and Competitor Prices on OAP Prices

	(1)	(2)	(3)	(4)
ln(Production Cost)	.197 (.015)	.200 (.030)	.413 (.031)	.097 (.038)
ln(Trade Cost)	.913 (.037)	.630 (.063)	.549 (.064)	.696 (.064)
ln(P˜)	.415 (.006)	.253 (.004)	.247 (.004)	.253 (.004)
Development Measure	OECD	OECD	Highly Educated	Ln(Per-Capita GDP)
Development	1.587 (.033)	1.693 (0.039)	1.017 (.035)	.685 (.024)
ln(Expenditure)	-.097 (.004)	.003 (.004)	-.003 (.004)	-.002 (.004)
Year and HS2 Dummies	Yes, Yes	Yes, No	Yes, No	Yes, No
Rho		.347	.347	.347
R2	.553	.362	.342	.343
Observations	47,573	47,573	47,573	47,573

Notes: Standard Errors in ( ). Regression (1) is estimated by OLS. Regressions (2), (3), (4) are estimated by random effects panel methods which allow for a first-order autoregressive error term.

Table 4: The Effect of Capital-intensity on Price Responses					
	(1)	(2)	(3)	(4)	(5)
ln(Production Cost)	.275 (.022)	.281 (.021)	.275 (.039)	.217 (.043)	.178 (.067)
ln(Production Cost)*ln(KY)				.321 (.186)	.363 (.206)
ln(Trade Cost)	1.611 (.132)	1.659 (.132)	-.342 (.172)	3.527 (.243)	1.229 (.319)
ln(Trade Cost) * ln(KY)				-7.888 (.988)	-5.284 (.934)
ln(P~)	.400 (.008)	.400 (.008)	.197 (.005)	.355 (.015)	.123 (.010)
ln(P~)*ln(KY)				.177 (.041)	.224 (.026)
OECD	1.528 (.041)	1.852 (.098)	2.122 (.097)	1.723 (.111)	1.982 (.113)
ln(KY)	-.606 (.045)				
ln(KY) *OECD		-.404 (.071)	-.718 (.060)	-.340 (.083)	-.751 (.074)
ln(KY) * (1-OECD)		-.665 (.044)	-.886 (.036)	-.521 (.054)	-.832 (.050)
ln(Expenditure)	-.099 (.004)	-0.098 (.004)	-.007 (.004)	-.095 (.004)	-.008 (.004)
Year and HS2 Dummies	Yes, Yes	Yes, Yes	Yes, No	Yes, Yes	Yes, No
Rho			.394		.394
R^2	.548	.549	.350	.554	.354
Observations	31,888	31,888	31,888	31,888	31,888

Notes: Standard Errors in ( ). Regressions (1), (2), and (4) estimated by OLS. Regressions (3), and (5) estimated by random effects panel methods which allow for a first-order autoregressive error term.

Table 5: The Effect of Country Education on Price Responses						
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Production Cost)	.338 (.023)	.406 (.040)	.349 (.023)	.416 (.040)	.078 (.025)	.301 (.043)
ln(Production Cost)* Highly Educ					1.284 (.056)	.672 (.086)
ln(Trade Cost)	.747 (.141)	.199 (.176)	.975 (.141)	.303 (.175)	1.212 (.158)	1.123 (.215)
ln(Trade Cost) *Highly Educ					-1.513 (.298)	-2.518 (.370)
ln(P˜)	.416 (.146)	.224 (.005)	.413 (.008)	.221 (.005)	.395 (.009)	.225 (.007)
ln(P˜)* Highly Educ					.024 (.011)	-.001 (.009)
Skilled Wage Percentage	.401 (.146)	.768 (.143)	-.713 (.150)	-1.244 (.193)	-.383 (.150)	-1.078 (.193)
Highly Educated	.934 (.029)	1.018 (0.44)	-.087 (.084)	-.562 (.111)	.381 (.112)	-.088 (.128)
Skilled Wage % * Highly Ed			2.833 (.251)	4.337 (.279)	1.989 (.255)	3.668 (.285)
ln(Expenditure)	-.102 (.004)	-.004 (.004)	-.104 (.004)	-.005 (.004)	-.101 (.004)	-.003 (.004)
Year and HS2 Dummies	Yes, Yes	Yes, No	Yes, Yes	Yes, No	Yes, Yes	Yes, No
Rho		.394		.394		.394
R2	.530	.313	.534	.319	.543	.333
Observations	31,888	31,888	31,888	31,888	31,888	31,888

Notes: Standard Errors in ( ). Regressions (1), (3), and (5) estimated by OLS. Regressions (2), (4), (6) estimated by random effects panel methods which allow for a first-order autoregressive error term.

Table 6: The Effect of Country Education Levels on Price Responses						
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Production Cost)	.394 (.023)	.467 (.040)	.459 (.040)	.345 (.041)	.021 (.027)	.249 (.045)
ln(Prod'n Cost)* ln(Education)* Highly Educated					.637 (.029)	.331 (.043)
ln(Trade Cost)	1.431 (.138)	.475 (.178)	.570 (.177)	.217 (.179)	1.078 (.163)	1.371 (.220)
ln(Trade Cost)* ln(Education)* Highly Educated					-1.028 (.148)	-1.610 (.177)
ln(P˜)	.415 (.008)	.220 (.005)	.218 (.005)	.219 (.005)	.390 (.009)	.229 (.007)
ln(P˜)* ln(Education)* Highly Educated					.007 (.005)	-.005 (.004)
Skilled Wage Percentage	.530 (.148)	.867 (.147)	-10.889 (.644)	.841 (.147)	.515 (.145)	.672 (.146)
Ln(Country Education)	1.062 (.029)	1.080 (.052)	-1.176 (.131)	.345 (.079)	.557 (.030)	.329 (.080)
ln(Country Education)*Highly Educated				.405 (.033)	.408 (.029)	.556 (.038)
Skilled Wage % * ln(Country Education)			6.628 (.353)			
ln(Expenditure)	-.099 (.005)	.001 (.005)	.002 (.005)	.001 (.005)	-.097 (.004)	.004 (.005)
Year and HS2 Dummies	Yes, Yes	Yes, No	Yes, No	Yes, Yes	Yes, No	Yes, No
Rho		.396	.396	.396		.396
R^2	.532	.306	.318	.310	.547	.330
Observations	30,868	30,868	30,868	30,868	30,868	30,868

Notes: Standard Errors in ( ). Columns (1) and (5) are estimated by OLS, while the remaining regressions in this table are estimated using random effects panel methods which allow for a first-order autoregressive error term.

Data Appendix

Trade data

Data on U.S. OAP imports for 1991-2000 were taken from United States International Trade Commission (USITC) trade data as reported in the December editions of the IM146A. While the data are recorded at the 10-digit HS level, the 10-digit data were first aggregated to the 8-digit level. The dependent variable for the analysis is the CIF unit value of imports, based on the 8-digit aggregates. Unit values were defined for each country (c) product (i) year (t) observation as, Unit $Value_{cit}$ = $[\text{Import value}]_{cit}$ /$[\text{Import quantity}]_{cit}$.

Competitor prices $P^{\sim}$ are the average price of similar 8-digit HS products imported through the OAP from all other countries in that year. Expenditure is defined by overall spending for OAP imports from all countries within an HS 8 grouping in the year, though other higher industry levels of aggregation were also tested for robustness.

U.S percentage of product value, $\alpha_{us,ic}$, was constructed from the OAP data, following the formula in footnote 10. Afterwards, the U.S. percentage $\alpha_{us,ic}$ was used to create the production and trade cost measures. To avoid endogeneity problems, the average $\alpha_{us,ic}$ for each county-product pair for the sample period was used when calculating production or trade costs.

To append industry data, HS product codes to 4-digit SIC industry identifiers were created by using Peter Schott's "HTS10 to SIC4 Concordance, 1989 to 2001" which is available from: http://www.som.yale.edu/faculty/pks4/sub_international.htm. Tariff rates and transportation costs used to create the trade cost measure, $[(1+g_{ict}) + (1-\alpha_{us,ic})^* \tau_{it}]$, were also collected from Schott's website.

Industry Characteristics

Data on 4-digit SIC industry capital-intensity, and skill requirements were collected from the NBER Manufacturing Database, which is available from the National Bureau of Economic Research data site, http://www.nber.org/data_index.html, as constructed by Bartlesman, Becker and Gray. Capital-intensity is measured as the ratio of Capital to output, while worker skill requirements were measured by the ratio of non-production worker wages to total wages.

Macroeconomic Variables

Macroeconomic Variables were collected from the Penn World Tables: Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002. The variable p, the price level of GDP, was used to measure country input costs in cost equation (1).

Education

Barro and Lee's data on educational attainment were downloaded from the National Bureau of Economic Research web site, http://www.nber.org/data_index.html. Following Riker and Brainard (1997), the high education indicator variable is set to one for all countries whose education level for adults 25 and older averaged 6 or more years in 1990.

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