OVERSEAS ASSEMBLY PRODUCTION CHOICES

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This article examines the input choices for producers who assemble their goods abroad and imported them to the United States through the U.S. Overseas Assembly Provisions. Three findings emerge. First, firms reduce their use of foreign parts and assembly when foreign costs rise, but only with a lag. In contrast, recent foreign cost increases boost the foreign portion of final product value. Second, the effects of cost changes are more pronounced for U.S. outsourcing imports from developing countries. Finally, the degree of production responsiveness differs with industry capital intensity and is the greatest for low-capital intensity projects performed in non-Organization for Economic Cooperation and Development (OECD) locations.

I. INTRODUCTION

Outsourcing can be viewed as a technological innovation that enables producers to geographically separate production processes. In this vein, theoretical work on the topic, including Jones and Kierkowski (1990), Arndt (2001), and Deardorff (2001), notes that international fragmentation of production processes enables producers to take advantage of factor price differences and may facilitate factor price equalization in cases where dramatic differences in factor endowments prevent trade in final goods from achieving factor price equalization. No doubt, these factors have given rise to the marked contribution of outsourcing to the growth of trade.[1]

One of the more fundamental decisions in this process involves firm choices regarding production techniques. In particular, firms must decide whether to use inputs from home or to purchase inputs in foreign markets. This decision is of great interest to countries, as it influences demand for their labor and their levels of economic activity. However, as recent work by Grossman and Helpman (2005) emphasizes, country cost differences are not sufficient in themselves to generate overseas fragmentation. While cost differences may cause firms to consider outsourcing in a low-cost location, a successful outsourcing venture requires the firms to first identify potential partners overseas. Further, if the firm succeeds in finding potential partners, it must induce the potential partners to make relationship-specific investments as a means of tailoring their abilities to the particular needs of the outsourcing firm. Alternatively, if the firm decides to keep the activity in house, the firm may need to make sizeable investments in the foreign host before production begins. However, while there is an understanding that outsourcing plays a large and growing role in international trade, there is a less well-developed understanding of the empirical factors that govern firm production choices.

The nature of production decisions is relevant for welfare, since the gains from trade generated by overseas outsourcing depend on the responsiveness of outsourcing decisions to cost changes. If the responsiveness of outsourcing trade to costs is large, Yi (2003) shows that

ABBREVIATIONS

OAP: Overseas Assembly Provision
OECD: Organization for Economic Cooperation and Development
SIC: Standard Industrial Classification

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1. Hummels et al. (2001) present evidence from 10 Organization for Economic Cooperation and Development (OECD) and 4 emerging markets indicating that increases in vertical specialization account for 30% of export growth between 1970 and 1990. In 1990 vertical specialization accounted for 21% of these countries' exports. A broad review of outsourcing trends is contained in Feenstra (1998). The growth of outsourcing is fostered by declines in tariff and transportation costs, as well as improved firm abilities to communicate and manage at a distance.

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the gains from trade are much larger than previously believed. However, very little is known about this fundamental element of trade.[2] As a result, quantifying how vertical specialization responds to country costs requires us to turn to empirical methods.

This article makes three contributions to the literature. First, the article shows that cost responses occur with a lag. An increase in a foreign country's costs reduce the relative contribution of foreign inputs two years down the road. In contrast, more recent cost changes in a country that is providing outsourcing items elevates the relative contribution of foreign parts and assembly. These effects are similar to the J-curve phenomenon that has been observed for overall trade flows. Second, the article highlights that the production responses are different for developing and developed countries. In particular, cost changes seem to have a larger influence on developing countries than they do on developed countries, suggesting that developing countries are more likely to produce in segments that are characterized by perfect competition. Finally, consistent with recent theories of outsourcing which note that the effects of costs may be diminished by procedural difficulties that are present in outsourcing relationships, the results show that cost responses are in fact largest for outsourcing that involves low capital intensity production in non-OECD locations.

The article is structured as follows. Section II reviews evidence from U.S. outsourcing in the Overseas Assembly Program. Details of the program and data characteristics are used to guide the empirical estimation that follows in Section III. Here, empirical tests examine how country costs have influenced production choices. The economic implications are discussed in Section IV, which is followed by a brief conclusion.

II. THE OVERSEAS ASSEMBLY PROGRAM AND PARTICIPATION PATTERNS

While aggregate statistics suggest that outsourcing activities have grown rapidly in recent decades, a general scarcity of data at the firm, or even industry, level has limited the close study of outsourcing decisions. As a result, one key method for gaining insights into these activities involves the study of specific programs that foster particular segments of outsourcing activity. Alternative methods for studying outsourcing decisions involve the study of outsourcing and trade activities conducted by multinational firms and their affiliates or study of the parts trade, which is assumed to be driven by outsourcing.[3]

This article takes the former approach, using data from the U.S. program known as the Overseas Assembly Provisions (OAP), which is codified in Section 9802 of the current harmonized system of tariffs.[4] The OAP program assists firms that use U.S.-origin parts, materials, or components in their overseas assembly operations. When OAP producers' final products are exported to the U.S. market they are not subject to tariffs on the portion of product value that originated in the United States; the collection of tariffs is limited to the dutiable value that is attributable to foreign value added. As a result, the operation of the OAP program creates a data opportunity for researchers, since its functioning requires the Customs Department to collect information on the product composition of OAP imports which details the relative contribution of U.S. and foreign origin value added.

A benefit of observing OAP imports is that the OAP program encompasses many types of organizational forms. Some OAP imports arrive from foreign assembly plants operated by firms headquartered in the United States. OAP imports also include goods that were assembled under contract by nonrelated foreign firms who used U.S. parts and components. Finally, OAP imports include products shipped by foreign multinational firms whose products include some U.S.-origin parts and components. While OAP products are assembled in a wide range of contractual or organizational methods, a unifying element for all of these trade flows is the fact that the items were assembled in a foreign location before they were shipped to the United States. While OAP imports do not include the universe of

2. Hanson et al.'s (2003) estimates for vertical specialization within U.S. multinationals are the exception. Another vein of work studies the effects of outsourcing (domestic and foreign) on firm performance. See Abraham and Taylor (1996), Feenstra and Hanson (1999), Head and Ries (2002), and Girma and Gorg (2004).

3. Swenson (1997), Feenstra (2000), Gorg (2000), and Swenson (2000) are examples of the program approach, while Zeile (1997) and Hanson et al. (2003) are representative of the approach based on the observation of multinationals. Yeats (2001) uses trade in parts and components to infer production sharing trade.

4. See Hanson (1997) for a history of the OAP.

TABLE 1
OAP Activity: Sourcing by Industry

SIC	Industry Name	OECD Countries		Non-OECD Countries	
		Foreign Percent	Obs.	Foreign Percent	Obs.
20	Food and Kindred Products	0.61	78	0.79	75
22	Textile Products	0.54	137	0.42	291
23	Apparel & other Textiles	0.58	828	0.51	3,803
24	Lumber & Wood Products	0.73	269	0.47	203
25	Furniture & Fixtures	0.72	324	0.66	182
26	Paper & Allied Products	0.51	204	0.34	243
27	Printing & Publishing	0.52	74	0.37	87
28	Chemicals & Allied	0.50	200	0.52	82
29	Petroleum & Coal	0.54	22	0.35	10
30	Rubber & Plastic Products	0.63	229	0.45	386
31	Leather Products	0.76	164	0.57	670
32	Stone, Clay & Glass	0.68	180	0.48	125
33	Primary Metal Industries	0.44	664	0.40	277
34	Fabricated Metal Products	0.68	894	0.44	514
35	Industrial Machinery	0.74	2,737	0.54	1,178
36	Electrical Machinery	0.68	2,518	0.51	2,839
37	Transportation Equipment	0.82	1,048	0.61	433
38	Instruments & Related Products	0.68	1,270	0.52	944
39	Misc. Manufactured Products	0.57	436	0.43	738
	All Industries	0.67	12,276	0.50	13,081

Foreign percent = [value of foreign inputs]/[total OAP product value].

outsourcing activity, OAP trade is responsible for a nontrivial fraction of imports, comprising 8% to 9% of U.S. import value in the typical year analyzed by this study.

The dataset follows U.S. OAP imports at the four-digit SIC industry level. At this level of aggregation, there are 399 separate industries and 64 different countries that participated in the program between 1980 and 1994.[5] One key decision for firms involved in the program is how to divide the purchase of inputs between the United States and foreign locations. To illustrate the heterogeneity in production techniques used by OAP producers, Table 1 displays the sourcing decisions for each of the two-digit SIC industries in the sample. Production decisions are represented by the foreign percent, which I define as the value of foreign content relative to the total value of the product imported through OAP.[6] For all industries, the average foreign percent of product value is 59%. However, two facts stand out. First, between industries there is a great deal of heterogeneity in the choice of foreign inputs. Two natural sources of variation are cross-industry differences in U.S. comparative advantage, and cross-industry differences in the relative importance of parts and assembly. Cross-industry differences in organizational form may also be related to input choices, though the effect of organizational form is more difficult to characterize. Table 1 reveals a second characteristic related to country development. In almost all industries, the foreign percent is much higher for the rich countries of the OECD than it is for the non-OECD countries, and the overall average is 67% for OECD producers, while it is only 50% for non-OECD producers of OAP products. One possible reason for this dichotomy may be related to the degree of interchangeability between foreign and U.S. production sites. Since the United States is more similar to the rest of the OECD, a greater fraction of the tasks can be conducted in those countries, which might otherwise be conducted in the United States. In addition, since costs are relatively high in the OECD, the high foreign

5. The data end in 1994, since the information on four-digit industry transportation costs and tariffs, which are needed for the cost analysis, are not available after that year.

6. The foreign percent (F_{jct}) is defined as the relative contribution of foreign inputs to product value, or $F_{jct} = [value\ of\ foreign\ inputs]_{jct}/[total\ OAP\ product\ value]_{jct}$. The subscripts j, c, and t refer to industry, country, and year, respectively.

TABLE 2
OAP Activity: Sourcing by Country

Country	Foreign Percent	Obs.	Country	Foreign Percent	Obs.
Argentina	0.66	34	Korea	0.69	809
Australia	0.66	330	Malaysia	0.64	487
Austria	0.72	180	Mauritania	0.86	2
Barbados	0.48	375	Mexico	0.38	2,658
Belize	0.30	62	Morocco	0.57	48
Belgium	0.73	448	Mozambique	0.49	45
Bangladesh	0.87	24	Mauritius	0.55	51
Bolivia	0.44	27	Nepal	0.96	22
Canada	0.65	2,883	Netherlands	0.70	528
Chile	0.74	43	New Zealand	0.74	71
China	0.69	694	Norway	0.60	110
Colombia	0.41	274	Pakistan	0.73	43
Costa Rica	0.37	490	Panama	0.41	112
Denmark	0.70	247	Peru	0.78	32
Dominican Republic	0.32	797	Philippines	0.67	698
Egypt	0.92	30	Poland	0.74	107
Finland	0.66	170	Portugal	0.58	141
France	0.64	872	Romania	0.66	18
Germany	0.67	1,196	El Salvador	0.40	274
Greece	0.64	127	Sierra Leone	0.38	13
Guatemala	0.38	214	Singapore	0.73	712
Guyana	0.31	88	Spain	0.71	210
Haiti	0.36	995	Sri Lanka	0.68	116
Honduras	0.35	233	St Kitts Nevis	0.42	649
Hong Kong	0.72	467	Sweden	0.69	478
Hungary	0.72	84	Switzerland	0.64	448
Indonesia	0.69	155	South Africa	0.59	52
Ireland	0.71	539	Thailand	0.70	301
Israel	0.51	149	Trinidad	0.42	69
Italy	0.69	766	Turkey	0.92	45
Jamaica	0.38	372	United Kingdom	0.65	1,210
Japan	0.71	1,404	Venezuela	0.37	29
Full Sample	0.59	25,357			

Foreign percent = [value of foreign inputs]/[total OAP product value].

percent observed in OECD locations is likely to also reflect the high cost of operations in the OECD.

To further examine the effect of country differences, Table 2 displays the foreign percent for all 64 countries in the OAP data sample. Notably, distance appears to influence production choices, as the foreign percent is generally higher for countries that are more distant from the United States than it is for countries that are nearer, as would be predicted by the desire to avoid high transportation charges.

The average foreign percent changed little over the sample interval, rising from 58% in 1980 and 59% in 1994. However, if one controls for changes in sample composition by removing country-industry fixed effects, a slow trend in growth of foreign input usage of 0.08% per year remains. However, if assembly incentives differ for developing and developed countries, it may not be sensible to measure a common time trend for all countries. While developed countries offer the benefit of consumer access, developing countries are usually thought to attract assemblers through low factor costs. The raw dataset exhibits distinct time trends for developing and developed countries. Once again, controlling for country-industry fixed

effects, the foreign percent of product value declined by 0.26% per year for overseas assembly in developed countries, while it rose by 0.69% per year for overseas assembly in developing countries. However, it is not clear that these changes were caused by new technologies or changes in outsourcing choices, as they are also consistent with differential changes in relative costs during the interval. While the costs of rich OECD countries rose by 1.36% per year versus the United States, foreign country costs for the average non-OECD country declined by 2.02% per year relative to the United States. This means that the general changes in the sourcing of foreign assembly and parts could be driven by cost minimization considerations rather than changes in outsourcing technology. To assess the relevant contributions of the two, we must turn to empirical methods.

III. ESTIMATION AND RESULTS

New theories of outsourcing have implications for the timing and flexibility of outsourcing production decisions. In this section I explore these theoretical predictions as I study how economic factors contribute to overseas production choices.

To study production sourcing decisions, the regression framework relates the relative contribution of foreign inputs to product value, the foreign percent, to the relative cost of producing parts and components in country c as compared with production costs for the United States. Since the dataset is based on production decisions for firms that participate in the OAP program, the correct measurement of relative costs requires adjustments that account for the benefits and costs associated with the use of the OAP program provisions. When parts and assembly are purchased abroad, the raw production cost C_c, which is the cost of production in country c, is augmented by ad valorem transportation and tariff costs, g_{jc} and τ_j.[7] It should be noted that while tariffs for industry j are common for all assembly locations, the transportation costs for each industry j differ across country locations, reflecting industry characteristics, distance, and geographical features that influence the cost of transport. Taken together, the implied cost of sourcing from country c is $C_c(1 + g_{jc})(1 + \tau_j)$. If the parts and components are purchased in the United States instead, the firm incurs production costs C_{us}. While the tariff provisions of the OAP exempt the U.S. contribution from tariff, the use of U.S. components elevates transportation costs since the U.S. inputs must first be shipped to the location of assembly and then shipped a second time when they are returned to the United States as part of the final product. This implies that the final cost of using U.S. parts in an OAP product is given by $C_{us}(1 + g_{jc})^2$. Combining these expressions yields the relative cost of producing abroad in country c, as compared with the United States:

$$\text{Relative cost} = \left[\frac{C_c(1+g_{jc})(1+\tau_j)}{C_{us}(1+g_{jc})^2}\right] = \left[\frac{C_c(1+\tau_j)}{C_{us}(1+g_{jc})}\right].$$

The cost measure captures the relative cost of producing in country c as compared with the United States and shows that there are three sources of cost variation. First, costs depend on the relative raw costs of producing abroad rather than in the United States, or C_c/C_{us}. Higher values of C_c/C_{us} will presumably create an incentive to complete more production stages in the United States rather than performing them overseas. The incentive to produce in the United States is further augmented by any tariffs τ_j, which elevates the relative cost of overseas production. However, the incentive to produce OAP components in the United States will be attenuated by transportation costs, g_{jc}, which increase the cost of including U.S. rather than foreign parts and components in the final product. To create the relative cost measure, country costs relative to the United States [C_c/C_{us}] were collected from the Penn World Tables[8] and combined

7. Time subscripts are dropped for simplicity.

8. 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. I use the variable P, the price level of gross domestic product, to proxy country costs. If price levels rise due to increases in country productivity, the variable will overstate the magnitude of cost increases.

TABLE 3
The Effect of Cost on Production Decisions Dependent Variable: Foreign Percent

	(1) Tobit	(2) Tobit	(3) Tobit	(4) RE Tobit	(5) Tobit RE	(6) Tobit
Rel_Cost_{t-1}	0.101	0.096	0.062	0.103	0.038	0.068
	(0.021)	(0.020)	(0.019)	(0.015)	(0.022)	(0.018)
*(non-OECD)					0.095	0.022
					(0.042)	(0.033)
Rel_Cost_{t-2}	−0.142	−0.139	−0.130	−0.060	−0.114	−0.045
	(0.021)	(0.021)	(0.020)	(0.016)	(0.024)	(0.019)
*(non-OECD)					−0.038	−0.167
					(0.040)	(0.033)
OECD	0.194	00.182				
	(0.009)	(0.006)				
Year	−0.010	−0.009	−0.011	−0.003	−0.011	−0.006
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Year^2	0.0007	0.0007	0.0007	0.0002	−0.0007	0.0003
	(0.0001)	(0.0001)	(0.0001)	(0.00008)	(0.0001)	(0.00008)
Controls	—	Industry	Industry, Country	Country-Industry RE	Country	Country-Industry RE
Log-Likelihood	−3,411	−2,627	−212	−1,504	−208	−1,576

Tobit and random effects Tobit regressions.
Standard errors in parentheses.
Each regression has 25,357 observations.
Foreign percent = [value of foreign inputs]/[total OAP product value].

with tariff data from Schott and transportation costs from Feenstra.[9]

Cost minimization implies that the relative contribution of foreign inputs will decline if the relative cost of foreign production is high. However, if production adjustments occur with a lag, or if production adjustments are costly, then the response to cost changes may be observed with a lag. To check for this possibility, the estimating equation is given by

$$F_{jct} = \alpha + \beta_1 * Rel\_Cost_{c,t-1} + \beta_2 * Rel\_Cost_{c,t-2} + \Sigma\delta_c + \Sigma\gamma_j + \lambda_{yr} * yr + \lambda_{yr2} * yr^2 + \epsilon_{jct}.$$

For OAP program participants, the difficulty of identifying new partners or in forming new contractual arrangements while previous contractual agreements are still in force are likely to influence adjustment lags. For this reason, I include both the relative costs from the previous period and two periods past.[10] To control for other sources of heterogeneity in production decisions, the estimating equation is rounded out with country controls, δ_c, and industry effects γ_j. Time and time squared are also included in the regression specification to account for evolution in outsourcing techniques that may be affected by changes in technology, communications, or other factors that influence the relative attractiveness of moving production stages and assembly to foreign locations. Since the dependent variable, *foreign percent*, is bounded between zero and one in magnitude, each of the regressions is based on Tobit or random effects Tobit techniques.

As the first four columns of Table 3 show, current production decisions are based on costs

9. Robert C. Feenstra's data, "U.S. Imports and Exports by 4-digit SIC Industry, 1958–94," posted and described at http://data.econ.ucdavis.edu/international/usixd/usixd4sic.html, were used to construct measures of transportation costs. Since there is no information on the cost of shipping inputs, I assume that the ad valorem cost of shipping inputs to the assembly location is the same as the ad valorem rate for shipping the final good. In general, this assumption may result in an overestimate of the cost of shipping inputs to the assembly location, as firms are likely to economize on the shipment of costly inputs. For example, a computer firm is likely to ship processors, which are light, to their assembly plants, while they purchase plastic components locally. Tariff data for four-digit SIC industries were collected from Peter Schott's Web page, http://www.som.yale.edu/faculty/pks4/sub_international.htm.

10. Current cost is not used, since firms are unlikely to be able to respond immediately. Other regressions that were not reported examine the importance of including cost lagged either one or two periods. The regression fit is better for the two-period lag than for a single lag. However, since both costs have statistically significant explanatory value, they are both included in the regressions.

both one and two periods earlier. The coefficients show that the foreign percentage of product value declines if the relative cost of foreign activity rose two periods ago, while the foreign percentage rises if costs rose in the previous period. This time pattern is consistent with firm decisions that reduce the use of foreign inputs when the relative cost of foreign inputs rises, but where firms can only adjust their purchasing decisions with a lag. This feature is consistent with the modeling assumptions that underpin Grossman and Helpman's (2005) theoretical treatment of sourcing decisions.[11] However, in the short run following a foreign cost increase, firms may be stuck with their current production arrangement. In this case, it is likely that firms will pass through at least part of the cost increase, causing an increase in the measured foreign percentage.[12]

The regression controls provide further insight into the nature of outsourcing relationships. For example, as the OECD coefficients in the first two columns of Table 3 show, the foreign percentage was almost 20% higher for OECD countries than it was for non-OECD countries.[13] The difference in production choices may arise because U.S. factor and productivity characteristics are more similar to those of other OECD nations than they are with non-OECD countries, enabling firms to replace more product value when a product is produced in an OECD location. In addition, the higher per-capita incomes of OECD countries, and the greater similarity between U.S. and other OECD consumers, may also mean that in addition to exports of the firm's products to U.S.-based OAP customers, a greater volume of output might also be demanded by the OECD country's consumers as well. In other words, if some stages of the production process require economies of scale, the demand similarity of OECD countries may lead to greater opportunities for meeting the scale requirement than is the case for non-OECD countries.

Time effects are also apparent in production decisions. Notably, the results show that the foreign percentage decreased over time, even if country-industry effects are included. For those who fear that overseas assembly will cause the loss of economic activity, this indicates that for those industries that continue to undergo joint production in the OAP program, outsourcing is not hollowing out the relative U.S. contribution to product value.[14] In addition, although Section II presented evidence that time trends appeared to differ between developed and developing countries, separate time coefficients are not reported, since they do not enter significantly if they are added to the regression specification. Instead, the differential time trends observed in the raw data are explainable by the differences in cost trends for OECD and non-OECD countries. A final determinant that emerges is the presence of significant coefficients on the two-digit SIC industry dummies. Their significance indicates that the level of the foreign percent is influenced either by comparative advantage or technological considerations that affect the ability to move production stages overseas. Nonetheless, while industry considerations exert a measurable influence on a firm's sourcing decisions, their presence or absence from the regression specification does not influence the magnitude of the cost coefficients.

The final two columns of Table 3 explore whether the relative cost effects have the same influence on outsourcing production decisions in developed OECD countries as they do on outsourcing production in non-OECD countries. To do this, variables that interact a non-OECD dummy with the relative cost measures are added to the previous estimation equation:

$$F_{jct} = \alpha + (\beta_1 + \theta_1 * \text{Non-OECD}) * Rel\_Cost_{c,t-1} + (\beta_2 + \theta_2 * \text{Non-OECD}) * Rel\_Cost_{c,t-2} + \Sigma\delta_c + \Sigma\gamma_j + \lambda_{yr} * yr + \lambda_{yr2} * yr^2 + \epsilon_{jct}.$$

If the production for developed and developing countries responds differently, the differential response for non-OECD production can be gauged by inspecting the coefficients θ_1 and θ_2. The estimation results indicate that

11. In their model, forming outsourcing relationships requires the identification of suitable partners, followed by the performance of relationship-specific investments to match the firm's product requirements.

12. If the contract is invoiced in the foreign country's currency, the full cost will be passed through. If it is invoiced in dollars, the foreign cost will rise if the contract allows for some pass-through of foreign production costs.

13. OECD is an indicator variable that is set to one for all countries that joined the OECD by 1985.

14. The same general trends are observed if I examine the time dummies over time rather than using a time trend. The choice of time specification does not affect the general conclusions regarding the other regressors.

the cost effects are magnified for non-OECD countries. Cost increases two periods ago cause a larger reduction in the foreign percentage for non-OECD countries; while cost increases a single period ago result in a slightly larger increase in the current foreign percentage. If production in a non-OECD country is hit by a cost increase one period back, it is passed through to a higher degree than cost increases experienced in developed countries of the OECD.[15]

While cross-country cost differences provide firms with an incentive to initiate further outsourcing relationships, a key idea in Grossman and Helpman's (2005) work is that the costs and difficulties involved in locating and creating a profitable outsourcing relationship may potentially reduce the desirability of outsourcing. One empirical prediction of Grossman and Helpman's (2005) work is that the cost sensitivity of outsourcing production relationships is likely to be smaller for industries where matching is more difficult and the probability of finding a profitable match is lower. I assume that the difficulty of locating and operating a match will increase with the capital intensity of the operation, which I proxy with the capital intensity of the U.S. industry.[16] For example, a low capital-intensity firm in the textile sector will probably have little difficulty in forming new partnerships, since the firm's requirements involve standardized services that are available in many locations, making them easy to characterize and contract for. By way of contrast, high capital-intensity industries, such as specialized medical diagnostic instruments, are likely to find it much more difficult to locate suitable overseas outsourcing opportunities because they have much more detailed requirements which make it difficult to locate workers or contractors with the appropriate expertise. As a result, firms in more capital-intense industries are likely to be less influenced by pure production cost alone.

To test this idea, I divide the sample into high and low capital intensity observations, where capital intensity is defined using Bartelsman et al.'s (2000) measures of capital/output.[17] As columns (1) and (2) of Table 4 show, the effects of cost increases two periods ago are very different for the two groups. Low capital intensity industries exhibit a cost response that is almost two times as large as the cost response observed in capital-intense industries. This suggests that those industries that can easily move away from high cost locations do.

A further question is whether the effect of capital intensity differs across production locations. Does low capital intensity production in OECD countries respond differently to changes in relative costs than does low capital intensity production in non-OECD countries? One might expect that the difficulty of locating a match would be smallest for searches in low capital intensity industries where low-level skills are sought than they are for searches in high demand, high capital industries that require high skills of a very specific type. To see whether this is the case, the data analysis is divided into two regressions: one for high capital intensity industries, the other for low capital intensity industries. Within each of these regressions, all regression coefficients are allowed to differ for OECD and non-OECD countries. These results are reported in columns (3) and (4) of Table 4. Of the observed production responses to cost changes experienced two periods back, the largest effect is noted for non-OECD countries producing low capital intensity products, which is consistent with the notion that the simplest searches are for the low capital intensity industries that are setting up facilities in non-OECD locations. The cost responsiveness for this group is more than twice as large as the responsiveness measured for low capital intensity industries located in OECD locations. As before, the cost responses for the low capital intensity industries are higher than for the high capital intensity industries.

IV. ECONOMIC IMPLICATIONS

To quantify the effect of a cost change, I consider a particular change in relative costs and apply the coefficients from the third regression in Table 3. For argument's sake, suppose that foreign relative costs for a particular

15. This finding is consistent with Swenson's (2004) conjecture that developing countries appear to face perfect competition, while developed countries are in segments that could be characterized by imperfect competition.

16. In related work, Antras (2003) argues that intrafirm trade will be higher in capital-intense industries due to greater potential difficulties with incomplete contracts in more capital-intense industries.

17. The data are taken from the NBER-CES Manufacturing Industry Database (2000), which is located on the NBER Web site at http://www.nber.org/nberces/nbprod96.htm.

TABLE 4
The Effect of Capital Intensity on Production Decisions
Dependent Variable: Foreign Percent

			(3) Low K		(4) High K	
	(1) Low K	(2) High K	OECD Countries	Non-OECD Countries	OECD Countries	Non-OECD Countries
Rel_Cost_{t-1}	0.092	0.106	0.077	0.040	0.042	0.069
	(0.029)	(0.027)	(0.028)	(0.054)	(0.029)	(0.057)
Rel_Cost_{t-2}	−0.175	−0.093	−0.038	−0.111	−0.029	−0.069
	(0.029)	(0.028)	(0.032)	(0.055)	(0.034)	(0.057)
Year	−0.011	−0.004	0.047	−0.131	−0.002	−0.152
	(0.003)	(0.003)	(0.035)	(0.046)	(0.041)	(0.052)
$Year^2$	00.001	0.0003	−0.0003	0.0008	00.0000	0.0009
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0003)
OECD	00.199	00.152				
	(0.009)	(0.009)				
Controls						
Industry*	Yes	Yes		Yes		Yes
Country				Yes		Yes
Log-Likelihood	−1401	−959		−593		−533
Observations	12,680	12,677		12,680		12,677

Tobit regressions.
Standard errors in parentheses.
The sample median capital/output for the full sample is used to define high and low K industries.
Foreign percent = [value of foreign inputs]/[total OAP product value].
*Columns (3) and (4) contain separate industry coefficients for OECD and non-OECD countries.

OAP assembly country increased by one standard deviation two periods ago and then remained permanently at their new level. This change would imply that the foreign percent would decline by 2.2%.[18] While this change is statistically identified, it is not extremely large when compared with the average level of the foreign percent, which is 59%.

The sizes of these effects are smaller than those observed by Hanson et al. (2003). One reason for the differences may be the unit of observation. Hanson et al. identify the responsiveness to costs by assuming that general effects can be proxied by fixed effects for parent firm and industry. This means that their sample of firms represents multinationals whose activities are spread across multiple countries. Since these firms have production facilities in many locations, they can move production from one location to the next if costs favor relocation. In contrast, not all OAP producers in this sample have facilities in multiple countries. As a result, they may not have the ability to quickly switch production between existing facilities. In the longer term, however, they may build new facilities or write new contracts in the future, though such changes arguably carry a higher fixed cost. The difference between my results and those of Hanson et al. suggests that organizational form may exert an important influence on the ability of firms to quickly respond to cost changes.

A second implication of my results is that the welfare effects associated with OAP operations are relatively small. Yi (2003) demonstrates that the expansion of fragmented production is especially likely to enhance welfare when there is a low elasticity of substitution. If OAP production, which has a low level of responsiveness, is representative of outsourcing in general, then the welfare gains from outsourcing may not be as large as the gains that are expected.

However, there are many reasons for being cautious about applying the lessons from OAP outsourcing decisions to all fragmented production in general. Notably, the OAP is designed to promote the use of U.S.-origin parts in foreign assembly. As a result, a large

18. The effect is calculated as $0.33*(0.062 - 0.130) = 0.022$, where the one standard deviation change of relative cost is 0.33 and the average level of relative cost is 0.772.

portion of the contribution of many foreign countries is assembly. If these tasks are well defined, and cannot be decomposed across countries, then there many not be much scope for substitution in ongoing operations. In other words, if the relative cost of foreign cost rises too much, the OAP production for an industry country pair may cease rather than moving more production stages back to the United States. In contrast, there may be much more potential for substitution and unbundling in the production of parts.

V. CONCLUSION

This article examines the input choices for producers who assemble their goods abroad and import them to the United States through the OAP. Three findings emerge. First, responses to relative foreign country costs imply that firms reduce their use of foreign parts and assembly when foreign costs rise, but only with a lag. In contrast, recent foreign cost increases boost the foreign portion of final product value. Second, the effects of cost changes are more pronounced for developing than for developed country activities. Finally, the degree of production responsiveness differs by the capital intensity of the industry, and is the greatest for low capital intensity projects performed in non-OECD locations. Such findings support the implications of recent theories of outsourcing which emphasize that while costs matter, other considerations, such as the potential for forming a good match, will also influence the form of outsourcing arrangements.

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