Foreign outsourcing and firm-level characteristics: evidence from Japanese manufacturers

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Current version: February 23, 2005

Abstract

Based on micro data of 118,300 firms without firm-size thresholds covering all manufacturing industries in Japan, this paper investigates the foreign outsourcing, distinguished explicitly from domestic outsourcing, at the firm level. Less than three percent of the firms are outsourcing their production across national borders. The fixed entry cost for foreign outsourcing is significant and related with the firm's human skills and foreign business experience. The firms tend to outsource more of their activities overseas when their productivity is higher or when their products are more labor-intensive.

Keywords: Foreign outsourcing; Firm-level data; Productivity; Capital-labor ratio

JEL classification: F1; F23; J31

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1. Introduction

More and more firms have located different stages of production processes in different countries, partly facilitated by recent development of information technologies (IT). This international fragmentation of production processes is accompanied by active outsourcing across national boundaries. Even for material-scarce Japan, manufactured intermediates now occupy far larger share in total imports than raw materials. The foreign outsourcing[1], at the same time regarded as a threat to domestic employment, has triggered political reactions, such as the Anti-Foreign-Outsourcing Bill proposal in the U.S. Congress. In spite of ample evidence from business anecdotes and aggregate statistics, however, efforts to empirically quantify foreign outsourcing, especially based on micro data, remain limited.[2]

Previous studies have calculated foreign outsourcing mostly from input-output tables (e.g. Campa and Goldberg (1997), Feenstra and Hanson (1996)). The use of these industry-level measures has immensely contributed to our understanding of foreign outsourcing, especially for comparisons across different periods and countries, but aggregate data are insufficient because, as will be reported later, a vast majority of firms are not actually involved in any foreign outsourcing at all. We need to investigate the inter-firm heterogeneity in foreign outsourcing, i.e. which types of firms choose to outsource their activities across national borders, or which firm-level characteristics, such as firm size, productivity, and capital-labor ratio, are particularly related with the firm's choice of foreign outsourcing.

On the other hand, a series of papers, including Antras (2003) and Grossman and Helpman (2004), have recently constructed formal models of foreign outsourcing based on the

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[1] This paper uses the term "foreign outsourcing," though other expressions, such as offshore outsourcing, offshoring, production sharing, or fragmentation, are used almost synonymously to describe the same phenomenon. The definitions will be discussed in the next section.

[2] The debates on this issue are widespread in general media as of this writing, but very few of them contain quantitative information, other than case episodes or future projections. For an overview, see Drezner (2004), for example.

incomplete contract theory. Interesting hypotheses on the relationship between foreign outsourcing and characteristics of firms have been derived from these models. Direct firm-level empirical tests of these theoretical predictions, however, have yet to be seen.

As far as the author knows, this paper is intended to be the first attempt at exploiting direct data of foreign outsourcing, distinguished explicitly from domestic outsourcing, at the firm level, from a large sample representing the whole manufacturing of a country.[3] This paper derives firm-level data from a survey, which samples more than 118 thousand firms, includes firms of any size, irrespective of their involvement in outsourcing, and covers all manufacturing industries in Japan. This survey also contains rich information on many firm-level characteristics, such as output, employment, capital, computers, and R&D, for example.

To preview the results, our firm-level data reveal that less than three percent of the firms are outsourcing their production activities across national boundaries. The Heckman's two-step estimation results show that the fixed entry costs for foreign outsourcing is actually significant and negatively related with the firm's human skills (or firm size) and foreign business experiences. Our estimates demonstrate that more productive firms tend to be more active in foreign outsourcing. This paper also finds that firms are likely to outsource more of their tasks overseas when their products are more labor-intensive.

The rest of the paper is organized as follows. Section 2 describes data. Section 3 explains our empirical specifications. Section 4 reports estimation results. Section 5 concludes.

2. Data description

2.1. Alternative measures of foreign outsourcing

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[3] As will be discussed later, there exist some micro-data studies of this topic, such as Gorg and Hanley (2003), and Swenson (2000), but their samples are from a limited number of plants/firms under a special policy program or in a particular industry.

This section briefly overviews various measures of foreign outsourcing. First, as already been extensively explored since Feenstra and Hanson (1996) and Campa and Goldberg (1997), the most often used source is the input-output table. To separate imports in total intermediate purchase, they define imported intermediate inputs for each industry i as

$$\sum_j \left[X_i^j \left(\frac{IMP_j}{CON_j} \right) \right] \qquad (1)$$

,where X_i^j is the input purchase of good j by industry i, which includes domestic as well as import purchases, captured in the input-output table, while IMP and CON are imports and apparent consumption of good j, based on *Census of Manufacturers* and foreign trade data.[4] Although input-output data are available consistently across almost all industries for many countries, the share of imported good j, (*IMP/CON*), in (1) is automatically constrained equal across all industries, irrespective of the industry by which the good j is purchased.[5]

Another problem of this approach is in the coverage. They define outsourcing by "the import of intermediate inputs by domestic firms" (Feenstra and Hanson (1996) p.240).[6] Thus, arm's-length input purchases not based on contracting-out are included, while outward processing of final products is not covered.

Second, as Yeats (2001) calculates from foreign trade statistics of OECD countries, the share of parts and components in total exports can be served as a measure of foreign

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[4] Hummels et al. (2001) calculate the imported input content of exports. Anderton and Breton (1999) use imports from low-wage countries as a proxy for foreign outsourcing for U.K.

[5] This data limitation is true for U.S., but imported inputs are separately measured in some cases (e.g. Germany (Geishecker (2002)), and OECD (Hummels et al. (2001))). Using input-output data of the importer country is also problematic because some of the final products are sold in the processing country or exported to the third country, instead of being re-imported back.

[6] As another measure for foreign outsourcing, the recent issue (March 2004) of U.S. *Survey of Current Business* refers to the share of imported goods and services in total sales, which is available only for the benchmark survey years (currently no later than 1999) in the U.S. case. For the same purpose, Haskel (1999), and Paul and Siegel (2001) used the purchased service data, though foreign and domestic purchases were not distinguished.

outsourcing. However, as Yeats (2001) himself chooses the expression "production sharing" rather than outsourcing in his paper, the foreign outsourcing is not necessarily export of parts and components, and could include processing of final products or trade in services.

Third, as excavated by Egger and Egger (2001), Feenstra et al. (2000), and Gorg (2000), under special policy schemes such as U.S. offshore assembly program or E.U. inward/outward processing trade, the government collects data of imported inputs, separated from domestic inputs. For foreign outsourcing data, they use the preferential tariff-exempted imports of finished products that are re-imported after being processed overseas from exported intermediates. Then, unless final products are imported back under special duty relief, contracted-out activities accomplished overseas are not included in their definition of foreign outsourcing. Hence, offshore assembly import or "outward processing is thus less comprehensive than cross-border sourcing" (Egger and Egger (2001) p.247).

Finally, micro data for foreign outsourcing have so far been very few. As far as the author knows, Gorg and Hanley (2003), and Swenson (2000) are almost the sole studies based on the foreign outsourcing data, distinguished from domestic outsourcing, at the micro level.[7] They must be regarded as valuable contributions to our knowledge under severe data constraint. However, Gorg and Hanley (2003) define outsourcing by imports of general intermediates, including purchases of standardized inputs from marketplace, while the data for Swenson (2000) covers only the firms located in the U.S. Foreign Trade Zones.[8] Besides, as the number of their observations is relatively limited (less than one thousand firms) drawn from particular sectors, their data are not intended to be a representation of the whole country.

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[7] For example, Head and Ries (2002) used the data of finished goods bought from other firms in the case of Japanese manufacturers, while Girma and Gorg (2002) studied industrial services of U.K. firms in three manufacturing sectors. Both of them, however, did not distinguish foreign from domestic outsourcing.

[8] The data used by Gorg and Hanley (2003), however, is information-rich, as service inputs are separated from materials in their data of imported inputs.

2.2. Description of our firm-level data

All the firm-level data used for this paper are derived from *the Basic Survey of Commercial and Manufacturing Structure and Activity* (Sho-Kogyo Jittai Kihon Chosa in Japanese).[9] See Appendix for detailed description of the data. In our sample, 118,300 manufacturers are surveyed. This sample size is remarkably large, matched almost only by U.S. *Census of Manufacturers*. Hence, we can interpret this survey as a good representation of the whole manufacturing in Japan. The survey contains various data at 1998, including sales, employment, capital, R&D expenditure, the number of computers, and industry classification.[10]

This survey is almost the unique source for the data of foreign outsourcing, distinguished explicitly from domestic outsourcing, sampled from a large number of firms, covering all firm sizes without any threshold.[11] Even if we expand our scope to any other country, such direct and overall measure of foreign outsourcing as in this statistics has not been available, as far as the author knows. The survey directly asks "contracting out (*gaichu*, in Japanese) of manufacturing or processing to other firms.[12]" This coverage is clearly broader than exports of parts and components, but excludes general intermediate purchases not based on specific contracts. This paper measures foreign outsourcing and domestic outsourcing by the yen value outsourced to firms located overseas and that to firms located inside the country,

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[9] We restrict our attention to manufacturing industries in the whole sample because the survey focuses on outsourcing of production-related tasks, as will be explained in the next paragraph. The problem derived from this focus will also be discussed later.

[10] Many other variables are covered in the survey, though some data related with our topics, such as ownership shares, are not collected.

[11] The *Basic Survey of Business Structure and Activities* (Kigyo Katsudo Kihon Chosa in Japanese) covers only limited numbers of large firms (defined as those both with more than fifty employees *and* with capital of more than thirty million yen). The share of foreign outsourcing firms is strikingly higher in this statistics than will be reported here.

[12] The quoted phrase is translated by the author from the questionnaire of the survey.

respectively.[13] Since basically any activities in the production processes, such as procurement of specialized components, processing of products (e.g. coating, slicing), and final assembly, are included, this survey is suited for the analysis of the production fragmentation.

Before reporting summary statistics, several notes should be in order regarding the definition of outsourcing in this survey. First, outsourcing of non-production overhead services is not covered, though offshore outsourcing of software programming currently attracts wide attention in general media.[14] Second, contracting-out to own subsidiaries is not separated in the outsourcing, as the survey asks firms to report all contracts with independent legal entities but no ownership share data are required.[15] Third, arm's-length purchases of standardized components are not included, because the survey defines the outsourcing as the contracting-out of tasks "following the firm's orders in spec, design, quantity, delivery and other dimensions."[16] If the firm decided to replace in-house parts production by components regularly available in marketplace, this type of outsourcing is not covered in our survey. Finally, contracting out by wholesalers/retailers is not included in our data of manufacturers. On the other hand, statistics reclassify manufactures into "wholesalers" if their main line of business has changed to wholesale even when they still retain some manufacturing activities. Thus, outsourcing of manufacturing is not included into our sample if the firms are no longer classified as manufacturers due to their active outsourcing in the past.[17] While we must note these

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[13] Gorg and Hanley (2003) used data of imported inputs, which may be wider than foreign outsourcing, in Irish electronics plants. Gorzig and Stephan (2002) distinguish external contract work from material inputs for German firms, but foreign and domestic purchases are aggregated.

[14] The Japan's *Basic Survey of Business Structure and Activities* collects data on outsourcing of services but only a dichotomous yes/no questionnaire for a limited numbers of large-sized firms with no distinction of foreign from domestic outsourcing.

[15] While transactions between parent firms and their foreign affiliates established by FDI are usually treated as intra-firm trade, discussed in contrast to arm's-length transactions based on outsourcing contracts, our outsourcing data do not distinguish these two types of trades.

[16] The quoted phrase is translated from the glossary appendix in the published report of the survey. Purchases of components are included in material expenses. Although the survey does not explicitly ask it, the word "contracting-out" implicitly assumes that the task had formerly been done internally.

[17] This firm status change seems not prevalent in most sectors. However, exceptionally in the

limitations in interpreting the results, numerous findings from this firm-level foreign outsourcing data deserve serious attentions.

The industry-level aggregate figures for foreign outsourcing from this survey are summarized in Table 1. The cross-industry variability is evident from this table.[18] The industries with relatively high percentage of firms outsourcing overseas include leather products, rubber products, apparel, electric machinery, and precision instruments. The former three are typical labor-intensive industries, while the latter two depend heavily on parts and components produced globally. These five industries, especially electric machinery and precision instruments, are also outsourcing relatively high values of tasks overseas relative to their output, as shown in the same table. Other sectors, including such capital-intensive industries as petroleum products and metal products, are inactive in foreign outsourcing. Although these inter-industry contrasts are interesting, we should not contend ourselves at this aggregation level because the intra-industry heterogeneity is enormous, as will be reported as follows.

2.3. Comparison of firm-level characteristics

Table 2 disaggregates these more than 118 thousand firms depending on their involvement in outsourcing ((1) firms with foreign and domestic outsourcing both strictly positive, (2) firms with positive foreign outsourcing but no domestic outsourcing, (3) firms with positive domestic outsourcing but no foreign outsourcing, (4) firms with no outsourcing at all). The comparison of firm-level characteristics across these four groups of firms reveals several noteworthy findings as follows.

First of all, very few firms are outsourcing their production activities across national

textiles/apparels industry, the published statistics from the same survey report that the value of manufacturing/processing tasks outsourced overseas by wholesalers is much larger than that by manufacturers in the same industry.

[18] The inter-industry differences reported from this survey are basically similar to those found in Japan's *Input-Output Benchmark Tables*, available only once in five years.

boundary. Less than three percent of our sampled 118,300 manufacturers are outsourcing their production overseas, while nearly half of the firms experience outsourcing within the country.[19] Thus, foreign outsourcing is not universally observed across all the firms, but instead is concentrated on a small group of firms. This indicates that we must explicitly consider the existence of some forms of fixed entry costs in discussing foreign outsourcing. Although contracting out to outside parties always involves costs, this sharp contrast in shares of domestic vs. foreign outsourcing firms implies that the contract costs tend to be more seriously burdensome for contracts across national borders, possibly reflecting extra costs for communications in different languages, and adjustments across different legal systems. In the next section, this paper will explicitly examine the entry costs, or fixed contract costs, for foreign outsourcing in the Heckman's two-step estimation procedure.

This low share of foreign outsourcing firms, however, does not mean that foreign outsourcing is unimportant from the following reasons.[20] First, as shown in the table, the foreign outsourcing values more than four percent of total sales in the firm active both in domestic and foreign outsourcing, and nearly twenty percent in the firms involved only in foreign outsourcing. Although direct data are not available in the survey, the share of outsourcing relative to total costs or to total input purchases must be even higher than these shares relative to gross output. Second, since the firms active in foreign outsourcing are on average substantially large-sized as will be discussed below, the impact on aggregate transactions is not negligible. Actually, the aggregate value of tasks outsourced to foreign

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[19] Firms with less than fifty employees are sampled with probability less than one in this survey. The sampling probability for different cells is not disclosed. The published aggregated statistics, after sampling adjustment, reports that only 2.0% of all firms are involved in foreign outsourcing.
[20] As forecasted by AeA (2004), "over time, Japan will outsource many more jobs than the United States as a percent of its workforce" (p.12) because of its aging population and restrictive immigration policies.

countries surpasses the value of material imports in Japanese manufacturing.[21] Besides, as was mentioned previously, our count excludes firms outsourcing non-production services or purchasing intermediates from marketplace. Finally, the competitive or efficiency effect of foreign outsourcing is likely to spill over to other non-outsourcing firms through market interactions.

Second, as shown in Table 2, the firms involved in foreign outsourcing tend to be substantially larger in terms of employment and of sales than firms outsourcing only to domestic firms or firms without outsourcing at all.[22] This firm-size difference may be related with the fixed sunk costs of searching for and contracting with technologically capable but low-cost firms in foreign countries. This issue will be examined in the next section by regressions.

Third, the labor productivity tends to be high in foreign outsourcing firms. This may indicate that foreign outsourcing results in higher productivity because firms can concentrate on efficient or innovative activities by contracting out labor-intensive tasks, or that only productive firms can choose foreign outsourcing due to the high fixed costs for foreign contracting.

Finally, the firms involved in foreign outsourcing are more likely to have higher human skills, either measured in terms of human capital-labor ratio *H/L*, per-employee R&D expenditure, or per-employee usage of computers.[23] This gap is consistent with the labor cost saving motivation for outsourcing, but, alternatively, also suggests that higher technological or managerial capability is required to perform outsourcing across national borders.

Although these descriptive statistics are rather self-explanatory, we will control for

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[21] The Input-Output Tables confirm that manufactured intermediates occupy larger share than materials/energy in Japan's total imports.

[22] The published aggregate statistics from the same survey show that the share of foreign outsourcing firms is almost ten-times higher among large-sized firms than among small-sized firms (12.9%>1.9%). The threshold firm size for this large/small distinction is 300 employees.

[23] Since this survey contains no data on employment disaggregated by skills or educational attainments, this paper uses the sales and general administration (SGA) expenses, which closely correspond to non-production overhead expenditures, as a proxy for human capital in the firm. Head and Ries (2002) provide convincing cases for the use of this same proxy in a similar context.

these factors simultaneously by regressions in the next section.

3. Empirical models

This section explains our empirical specifications. Following Abraham and Taylor (1996), this paper estimates the reduced-form, which relates the foreign outsourcing intensity with a wide range of firm's characteristics:[24]

$$\ln\left(1+\frac{FO_i}{Q_i}\right) = \alpha + \beta_1 \ln\frac{Q_i}{L_i} + \beta_2 \ln\left(1+\frac{PC_i}{Q_i}\right) + \beta_3 \ln\frac{K_i}{L_i} + \beta_4 \ln\left(1+\frac{H_i}{L_i}\right)$$
$$+ \beta_5 \ln\left(1+\frac{R\&D_i}{Q_i}\right) + \beta_6 \ln Q_i + \gamma DUM + u_i \tag{2}$$

The suffix i indexes the firm. The dependent variable is the value of foreign outsourcing FO normalized by the firm size, which is measured in sales, Q, since no data for total purchases or costs are available in the survey. The disturbance term is denoted by u. The vector of dummy variables for two-digit industries, DUM, is included to control for industry-specific factors. To include a large number of firms with zero values into our regressions, we add one before taking logarithm for some variables. Although this specification (2) flexibly includes various determinants for outsourcing, we should not interpret this regression as a causal relation because they are simultaneously determined.[25] As the foreign outsourcing data is not observed in a large number of firms in our sample, this paper estimates (2) by the Heckman's two-step procedure, with the selection mechanism explained later. The expected sign for individual coefficient estimate is as follows.

The first term, *Q/L*, is intended to test the hypothesis that firms active in foreign

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[24] Girma and Gorg (2002) apply basically the same specification to firm-level outsourcing data, though they did not distinguish foreign from domestic outsourcing. Antras (2003) uses almost the same explanatory variables for the intra-firm trade regressions at the country-industry level.
[25] As our data set is in a cross-section format where finding instrumental variables is practically difficult, the control for possible simultaneity will be left for future independent work.

outsourcing have higher productivity ($\hat{\beta}_1 > 0$) than firms totally supplied by in-house

production or only with domestic outsourcing, as shown by Antras and Helpman (2004).[26] The

intuition behind this hypothesis is that only productive firms can choose foreign outsourcing

because the outsourcing across borders entails high fixed costs.[27] In our cross-section format,

the positive sign for the coefficient on productivity is also expected when extensive foreign

outsourcing of production tasks enables firms to concentrate on innovative activities and results

in higher productivity.[28]

The second term, the intensity of computer usage, measured by the number of computers

relative to the firm size *PC/Q*, is for testing the cost-reduction effect of IT. We investigate

whether advanced information technology, probably enabling more extensive, frequent, and

quick use of e-mail communications, internet search, and digital information sharing, reduces

the contract costs ($\hat{\beta}_2 > 0$).

The third and forth terms are supposed to test the hypothesis derived from the recent

incomplete contract model of outsourcing. Antras (2003) theoretically proves that the

outsourcing decreases its attractiveness with the capital intensity.[29] He also finds empirical

supports for his hypothesis by the industry-level finding of active intra-firm trade in

capital-intensive sectors and by business reports that investment in capital is easier to share than

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[26] We have confirmed that most of our main results remain robust even if the quasi TFP (total factor productivity) ($= Q/L - K/3L$) is used instead.

[27] While the models by Antras (2003) and Antras and Helpman (2004) emphasize the contrast between a wholly integrated affiliate and a purely independent firm, there exist many partially-owned joint ventures. The implication of their model, however, remains applicable since a firm inevitably faces the incomplete contract problem even in contracts with majority-owned firms.

[28] Focusing on the tradeoff between managerial overload and the holdup, Acemoglu et al. (2002) show that outsourcing becomes more active as the productivity of the firm rises closer to the technology frontier.

[29] In a similar framework, Antras and Helpman (2004) show that the outsourcing is less active when the headquarter services is more important than manufactured components. However, these models are not the sole incomplete contract models of foreign outsourcing. Grossman and Helpman (2004) focused on partial monitoring of efforts. Feenstra and Hanson (2003) estimated the effects of the relationship specificity on outsourcing by using processing trade data in Chinese regions.

investment in labor inputs.[30] Investment cost sharing alleviates the holdup problem, and raises the attractiveness of vertical integration. As the human capital should work similarly in this context of integration decision, this paper includes the physical capital-labor ratio *K/L* and the human capital-labor ratio *H/L* into (2) to test this holdup hypothesis.

The fifth term is the R&D intensity, which is measured in term of the ratio over sales, as usual (*R&D/Q*). The coefficient will be positive because active foreign outsourcing creates greater incentives for innovation by lowering production costs and raising profits, as formalized by Glass and Saggi (2001). The positive relation is also expected when managers can concentrate on innovative activities by outsourcing production tasks, or when only technologically capable firms can handle outsourcing overseas.

The last term controls for the firm size effect. The size of the sales *Q* is supposed to capture many size-related characteristics not represented by the terms above explained. For example, larger firms may find foreign contracting partners more easily due to their high reputation or stronger bargaining power in the marketplace.

This paper also estimates the following alternative specification to distinguish the effects of foreign outsourcing from outsourcing in general.

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\ln\left(1+\frac{FO}{DO}\right) = \alpha + \beta_1 \ln\frac{Q}{L} + \beta_2 \ln\left(1+\frac{PC}{Q}\right) + \beta_3 \ln\frac{K}{L} + \beta_4 \ln\left(1+\frac{H}{L}\right)
$$
$$
+ \beta_5 \ln\left(1+\frac{R\&D}{Q}\right) + \beta_6 \ln Q + \gamma DUM + u
$$

(3)

The dependent variable is replaced, in this specification, by the foreign outsourcing relative to domestic outsourcing. The yen value of contracts outsourced to domestic firms is denoted by *DO*. The significant coefficient estimates for a right-hand side variable in (3) indicate that the

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[30] Antras (2003) also refers to active procurement assistance in capital equipment and local independence in hiring workers in the real world as additional evidence supporting this hypothesis.

variable has a stronger association with foreign outsourcing than domestic outsourcing.

The existence of firms without any outsourcing has so far been neglected in our empirical specification.[31] However, since nearly 98 percent of the firms in our sample are not at all involved in any foreign outsourcing, and since the selection mechanism is supposed to differ from the relationship specified above, this paper introduces the following selection equation as the first-stage in Heckman's two-step estimation procedure:

$$\begin{aligned} \Pr\{FODUM = 1\} &= \Phi(Z\delta) \\ FODUM &= 1\{Z\delta + v > 0\} \end{aligned} \tag{4}$$

where Φ denotes the cumulative probability density function of v, which is distributed to the standard normal distribution. *FODUM* takes the value of one if the firm is outsourcing at least some of its activities across national borders, zero if the firm is not involved in any foreign outsourcing at all. As the factor affecting the selection of foreign outsourcing firms, Z, this paper considers the human skills (H) and the foreign business experience of the firm.[32] Since contracting with foreign firms requires searching for firms in foreign countries, negotiating with potential partners in foreign languages, and concluding a contract with foreign firms in different legal systems, at least some level of human skills is necessary for foreign outsourcing.[33] However, the fixed entry costs for foreign contracting are likely to be reduced if the firm has already had business experiences in foreign countries. As a measure of the firm's experience in foreign business, this paper introduces the dummy for foreign direct investment *FDI*.[34]

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[31] This negligence is observed also in theoretical modeling. An exception is Egger and Falkinger (2003), formally considering the case where only some firms within an industry are outsourcing.

[32] Our principal findings remain basically robust even if all the explanatory variables in the second-stage regression are not excluded from the first-stage selection equation.

[33] Most of the main findings are robust even if the firm size is used instead of human skills.

[34] The dummy is defined to take the value of one if the firm has at least one foreign affiliate, irrespective of the ownership shares, and zero otherwise. The human skill H is in logarithm.

4. Estimation results

This section reports the regression results from our firm-level data and discusses their implications. Before reporting regression results, an overview of summary statistics, shown in Table 3, will be useful. The figures in the table show that the per-firm average value of foreign outsourcing is larger than that of domestic outsourcing when we focus on outsourcing firms. Combined with previously reported statistics, this contrast indicates that large-sized manufacturers are outsourcing relatively large value of activities across national borders once they decide to begin foreign outsourcing. This observation appears consistent with high fixed costs for foreign contracting. Other figures in the same table also bring us rich information, such as very low share of firms directly investing abroad, for example. Remarkably large cross-firm standard deviations suggest that we can exploit rich inter-firm heterogeneity in our regressions.

Next, Table 4 summarizes correlation between variables. The extent of foreign outsourcing is not highly correlated with variables of our concern. Among them, the productivity, the human capital-labor ratio, and the FDI dummy have relatively noticeable positive correlations. Though the positive sign is as expected, we must wait for regressions simultaneously controlling for many factors.

The regression results are shown in Table 5. Noteworthy findings are as follows. First of all, the inverse Mill's ratio λ is statistically significant at any conventional significance levels in all cases reported in the table. This indicates that we cannot ignore no outsourcing firms in discussing the relationship between outsourcing and firm-level characteristics. Any estimation results from samples excluding no outsourcing firms should be biased. Since the inverse Mill's ratio is significant also in the regression with foreign vs. domestic outsourcing in the column (2), the fixed entry barriers for outsourcing is especially evident for outsourcing to foreign firms.

Second, the coefficient on the productivity is estimated to be significantly positive in the

regression on foreign outsourcing. This result is exactly as expected, consistent with our finding from descriptive statistics reported in the previous section, and also supports the theoretical prediction by Antras and Helpman (2004).[35]

Third, more active use of computers is positively related with more extensive outsourcing. As this communication cost reduction effect of IT is found insignificant in the column (2) of this table, the spread of recent IT contributes to the reduction of barriers for contracting with firms in any locations, foreign or domestic.

Fourth, as predicted theoretically by Antras (2003), the estimated coefficients on the physical capital-labor ratio and on the human capital-labor ratio are significantly negative. In other words, firms producing labor-intensive goods tend to extensively outsource their activities. This result sounds plausible because hiring and managing workers require local knowledge while costs for investments in physical capital can be relatively easily shared between final-good producers and suppliers. As far as the author knows, this is the first empirical evidence supporting the theoretical prediction on the relationship between outsourcing and capital-labor ratio at the firm level.[36] The same finding is also consistent with an alternative but widely held interpretation that foreign outsourcing from Japanese manufacturers, pressurized to cut high labor costs in Japan, tends to be concentrated in labor-intensive tasks.[37]

Since these two coefficients on capital-labor ratios are significantly negative also in the regression on the foreign outsourcing relative to domestic outsourcing, as reported in the column (2) of the table, the holdup problem appears more serious in contracts with foreign firms than with firms in the same country. Considering tremendous information imperfection across

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[35] If the quasi TFP is used, the coefficient is estimated not positive. This result may partly be affected by the simultaneity in cross-section data, or by the correlation with K/L.

[36] The industry-country level regressions by Antras (2003) failed to detect the significant effect of human capital, though physical capital was found significant.

[37] Our cross-section data set is not suitable for tracking the longitudinal rising capital-labor ratio as a result of active outsourcing of labor-intensive tasks.

national boundaries, this finding is exactly as predicted.

Fifth, the firms more active in R&D tend to be involved in significantly more extensive foreign outsourcing, as consistent with Glass and Saggi (2001). However, as the insignificant coefficient on R&D in the column (2) of Table 5 suggests, R&D appears positively related with outsourcing in general.[38]

Furthermore, if combined with our previous finding on computers, this result indicates that the firms investing more in high-technology capital are likely to be more active in outsourcing. Previous studies have often analyzed the same issue in the context of "technology vs. trade." For example, Feenstra and Hanson (1999) reported that the contribution of computers to the increasing wage inequality in the U.S. is larger than foreign outsourcing. Our findings, however, demonstrate that outsourcing and computers/R&D spending are actually intertwined at the firm level.

Sixth, as the sign of the firm size coefficient shows, the foreign outsourcing ratio does not rise proportionally as the firm size becomes large.[39] This issue will be discussed in the next paragraph on the selection equation results.

Finally, as the factor selecting firms or determining the fixed entry costs for foreign outsourcing, the firm's human skill level and foreign business experience are found statistically significant.[40] These factors affect the firm's decision whether or not she enters into the foreign outsourcing in the first place, significantly and sizably. For example, our estimates suggest that the probability that the firm chooses foreign outsourcing when she owns an affiliate overseas is around four times higher than that when she has no experiences in FDI (0.08 vs. 0.02),

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[38] Antras (2003) found active intra-firm trade in R&D-intensive industries, but his assumption that the investment cost sharing in R&D is as easy as that in physical capital is not necessarily plausible.
[39] All the estimated coefficients in the second-stage regression are, though statistically significant at any conventional significance levels, quantitatively small in terms of the elasticity evaluated at the mean.
[40] Even if other explanatory variables included in (2) or (3) are added to the selection equation (4), these two variables remain statistically significant.

evaluated at the mean. Similarly, one standard deviation increase from the mean in human capital nearly doubles the firm's probability of outsourcing overseas.[41] We have also confirmed, though omitted from the table, that the main results remain robust even if the human capital is replaced by the firm size.

Although the negative coefficient on the firm size in the second-stage regression seemed at odd with our previous finding of substantially larger size of average foreign outsourcing firms in descriptive statistics, the firm size is found positively related with the first-stage dichotomous selection of foreign outsourcing firms. Thus, larger firms are more likely to choose foreign outsourcing. At the same time, the intensity of foreign outsourcing relative to firm size does not increase as much as the firm size, once the firm decides to outsource across national borders. This observation is consistent with the general nature of fixed costs.

5. Concluding remarks

This paper has investigated the foreign outsourcing at the firm level. Our firm-level data have revealed previously unnoticed cross-firm heterogeneity. In our sample, nearly 98 percent of the firms are not outsourcing any of their production overseas at all. Motivated by this low share of foreign outsourcing firms, this paper examines the relationship between the firm's choice of foreign outsourcing and various firm-level characteristics. The firms with richer human skills or experiences in FDI are more likely to begin foreign outsourcing. More extensive outsourcing across borders tends to be observed in the firms whose productivity is higher or whose products are more labor-intensive. These findings contribute to our quantitative understanding of international production fragmentation, but we must be cautious in evaluating numerical magnitudes because of the data limitations. Among other things, we will need to seek foreign

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[41] Both of these probabilities are calculated from the standard normal probability of *FO*>0, setting other variables at the sample mean (*H* in logarithm), given the probit estimates reported in Table 5.

outsourcing data of non-production services, as it is supposed to be rapidly increasing.

As a final note, we will also have to further check the robustness of our results, which depend solely on the Japanese data. For example, the share of firms active in foreign outsourcing might be higher in other countries such as U.S. than that reported in this paper, since the Japanese economy is famous for the high share of tiny-sized firms.[42] As far as we know, however, no other firm-level data of foreign outsourcing, distinguished explicitly from domestic outsourcing, with comprehensive coverage of industries, are currently available. Consequently, international comparisons will be left for independent studies in the future.

Appendix Description of data

All the firm-level data used for this paper are derived from *the Basic Survey of Commercial and Manufacturing Structure and Activity* (Sho-Kogyo Jittai Kihon Chosa in Japanese). This paper is a part of the results from the access to micro data on manufacturers, allowed by the Ministry of Public

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[42] This U.S.-Japan difference in industrial organization was pointed out by Prof. Gary Saxonhouse. The recent foreign outsourcing by Japanese firms could also be interpreted as a historical development from traditional subcontracting between Keiretsu-related firms.

Management as No. 428. This survey was conducted only once in 1998. As long as I have confirmed by interviews, the government has no plan to continue this survey in the same format.

The survey is designed to cover firms in all sizes. Although the survey is not a census, the sample is intended to be representative of the population of all firms. Although all the firms with fifty or more employees are surveyed with certainty, firms with less than fifty employees are sampled with varying probability depending on such factors as industry affiliation or employee size. The government does not release the sampling probability for each industry-size cell.

The used data are as follows. The employment (L) is "total regular employees (Answer No. 4)" in the head number count. The output, Q, is "sales value (No. 11)," as no data on value-added are reported. The capital, K, is "tangible fixed asset (No.47)." Since no data of costs or input purchases are available, "sales and general administration (SGA) expenses" (No.20) is used as a proxy for human skills, H. All the values, except L, are reported in million yen. Table 2 classifies firms with foreign outsourcing values positive, even those less than one million yen, as "foreign outsourcing firms," and firms explicitly answering no foreign outsourcing or no response as "firms with no foreign outsourcing." The same classification is applied to domestic outsourcing firms.

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Table 1

Comparison of foreign outsourcing across industries

INDUSTRY	Number of Firms (% share)	Value FO/Q (% share in sales)
12. Food manufacturing	0.38	0.10
13. Beverage, Tobacco & Feed	0.50	0.02
14. Textile	1.22	0.09
15. Apparel & Textile products	3.18	1.54
16. Timber & Wooden products	1.08	0.29
17. Furniture & fixture	0.98	0.26
18. Pulp & Paper products	2.04	0.24
19. Printing & Publishing	1.67	0.05
20. Chemical products	1.78	0.07
21. Petroleum & Coal products	1.38	0.00
22. Plastic products	1.70	0.53
23. Rubber products	3.24	1.09
24. Leather & Fur products	5.02	1.68
25. Ceramic, Stone & Clay products	0.97	0.29
26. Iron & Steel	1.99	0.06
27. Nonferrous Metals	1.92	0.13
28. Metal products	1.28	0.09
29. General Machinery	2.35	0.75
30. Electric Machinery	3.29	2.84
31. Transportation Equipment	2.70	0.74
32. Precision Instruments	4.34	3.41
34. Miscellaneous manufacturing	3.53	1.29

Notes: The first column shows the industry classifications. The second column reports the percentage share of foreign outsourcing firms in the total numbers of firms. The third column reports the percentage share of values outsourced across national borders relative to total sales. All ratios are calculated from published aggregate data in Table 12-1 of *Report on the Basic Survey of Commercial and Manufacturing Structure and Activity* Vol.1 (pp. 464-475).

Table 2

Firm-level Characteristics and Outsourcing

	(1) FO-DO	(2) FO-*No* DO	(3) *No* FO-DO	(4) *No* FO-*No* DO
Number of Firms	2,929	234	55,032	60,105
Employment	447	104	81	37
Sales	24,689	8,150	3,018	1,176
Productivity	28.69	30.65	20.99	15.63
H/L	5.25	5.86	4.37	3.82
R&D/Q	2.49	2.59	2.37	3.48
R&D/L	0.830	0.641	0.526	0.527
PC/L	0.218	0.200	0.161	0.086
PC/Q	9.53	11.80	10.19	9.07
K/L	7.76	7.73	6.60	6.75
FO/Q	4.07	19.67	0	0
DO/Q	19.62	0	16.64	0

Notes: All the firms are grouped into the four categories: FO-DO (firms with foreign and domestic outsourcing both strictly positive), FO-*No* DO (firms with positive foreign outsourcing but no domestic outsourcing), *No* FO-DO (firms with positive domestic outsourcing but no foreign outsourcing), *No* FO- *No* DO (firms with no outsourcing at all). The cross-firm average for each group is shown in the table. The ratios of outsourcing and R&D-sales are in percentage. The employment *L* is measured by the number of regular employees, while *PC* is in terms of the number of computers. All the other values are in million yen (thousand yen only for *Q* in the PC ratio).

Table 3

Summary statistics

	Number of observations	Average	Standard deviation
FO	3,163	898.5	12672.3
DO	57,961	723.7	19087.5
Q	118,300	2629.1	45975.8
L	118,300	67.8	620.2
K	96,515	992.7	14520.4
H	118,300	445.2	7833.2
R&D	19,314	459.0	7595.7
PC	113,945	21.7	527.5
FDI	118,300	0.0458	0.2091

Notes: All the variables, except for *L, PC*, and the *FDI* dummy, are in terms of million yen.

Table 4

Correlation between variables

	FO/Q	*Q*	*Q/L*	*K/L*	*H/L*	*R&D/Q*	*PC/Q*	*FDI*
FO/Q	1							
Q	−0.005	1						
Q/L	0.139	0.210	1					
K/L	−0.001	0.104	0.275	1				
H/L	0.110	0.190	0.576	0.254	1			
R&D/Q	0.014	0.221	0.075	0.059	0.161	1		
PC/Q	−0.060	0.009	−0.158	−0.051	−0.035	0.252	1	
FDI	0.139	0.172	0.205	0.107	0.130	0.185	−0.032	1

Notes: The number of observation is 2,858. All the variables are before taking logarithm.

Table 5

Regression results

	(1) FO/Q	(2) FO/DO	(3) FO/Q	(4) FO/Q	(5) FO/Q
Productivity	0.0385	0.1583	0.0370	0.0289	0.0378
	(0.0036)	(0.0256)	(0.0035)	(0.0028)	(0.0035)
Computers	0.2784	−0.0550	0.2325	0.2499	0.3138
	(0.0993)	(0.8773)	(0.0990)	(0.0997)	(0.0977)
K/L	−0.0037	−0.0127	------	−0.0038	−0.0036
	(0.0014)	(0.0098)		(0.0014)	(0.0014)
H/L	−0.0146	−0.1163	−0.0140	------	−0.0136
	(0.0034)	(0.0243)	(0.0034)		(0.0034)
R&D	0.1386	0.2460	0.1402	0.0901	------
	(0.0720)	(0.5079)	(0.0608)	(0.0713)	
Firm size	−0.0178	−0.0881	−0.0186	−0.0148	−0.0175
	(0.0017)	(0.0129)	(0.0017)	(0.0015)	(0.0017)
χ^2	572.55	277.13	595.95	554.88	567.87
Selection Eq. *H*	0.1548	0.1649	0.1480	0.1548	0.1548
	(0.0049)	(0.0051)	(0.0048)	(0.0049)	(0.0049)
FDI	0.7076	0.6544	0.7065	0.7076	0.7076
	(0.0251)	(0.0260)	(0.0250)	(0.0251)	(0.0251)
Inverse Mill's ratio	−0.062	−0.416	−0.061	−0.051	−0.063
	(0.007)	(0.051)	(0.007)	(0.006)	(0.007)
Number of Firms	116,069 (Censored =113,009)	116,096 (Censored = 113,290)	116,169 (Censored = 113,009)	116,096 (Censored = 113,009)	116,096 (Censored = 113,009)

Notes: Shown are the results from Heckman's two-step estimation. The figures in parentheses are estimated standard errors. The second-stage regression includes industry-specific dummy variables in all cases. While it is relative to domestic outsourcing in the column (2), the dependent variable is the foreign outsourcing relative to firm size in all other cases. All the variables, except dummies, are in logarithm.