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

Eiichi Tomiura[*]

Research Institute for Economics and Business Administration, Kobe University, Japan

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Abstract

By using micro data of 118,300 firms without thresholds in all manufacturing industries in Japan, this paper investigates the foreign outsourcing, distinguished from domestic outsourcing, at the firm level. Merely around two percent of the firms are outsourcing their activities across national borders. The fixed entry costs for foreign outsourcing is significant and negatively related with the firm's human skills and foreign business experience. More extensive foreign outsourcing is observed in the firms with higher productivity, using more computers, and producing more labor-intensive goods.

Keywords: Foreign outsourcing; Firm-level data

JEL classification: F1; F23; J31

[*] Eiichi Tomiura, Research Institute for Economics and Business Administration, Kobe University, 2-1 Rokko-dai, Nada-ku, Kobe City 657-8501 JAPAN. Phone: +81-78-803-7008. Fax: +81-78-803-7059. E-mail: tomiura@rieb.kobe-u.ac.jp.

1. Introduction

More and more firms have located different stages of production processes in different countries in recent years, partly facilitated by trade liberalization and recent development of information technologies (IT). This international fragmentation of production processes is accompanied by active outsourcing across national boundaries. In spite of ample evidence from business anecdotes and aggregate statistics, however, efforts to empirically quantify foreign outsourcing, especially at the micro level, remain limited.

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 and capital-labor ratio, are particularly related with the firm's choice of foreign outsourcing.

On the other hand, theoretical models of foreign outsourcing have recently been constructed based on the incomplete contract theory by a series of papers, including Antras (2003) and Grossman and Helpman (2002). While these models have provided us with interesting testable results, direct firm-level empirical investigations of these predictions have yet to be seen.

As far as the author knows, this paper is intended to be the first attempt of exploiting direct data of foreign outsourcing, distinguished explicitly from domestic outsourcing, at the

firm level, from a large sample representing the whole manufacturing in any country.[1] This paper derives firm-level data from a survey, which samples more than 118 thousand firms, includes firms of any size without any thresholds, irrespective of their involvement in outsourcing, and covers all manufacturing industries in Japan. This survey also contains rich information on a wide range of firm characteristics, including output, employment, capital, R&D, and the yen value of foreign outsourcing, for example.

To preview the results, our firm-level data reveal that merely around two percent of the firms are involved in foreign outsourcing. The Heckman's two-step estimation results show that the fixed entry costs for foreign outsourcing is actually significant, and appears negatively related with the firm's human skills and foreign business experiences. Our regression estimates also demonstrate that more extensive foreign outsourcing tends to be observed in firms with higher productivity, and with more active use of computers. As is consistent with the theoretical prediction from the incomplete contract model by Antras (2003), this paper finds that firms are likely to be more deeply involved in foreign outsourcing when they produce more labor-intensive products.

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

This section briefly overviews various measures of foreign outsourcing. First, as already extensively explored by Feenstra and Hanson (1996, 1999) and by Campa and Goldberg

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

(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

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

, 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.[2]

Although input-output data are available consistently across almost all industries for many countries, this measure has some drawbacks. For example, the share of imported good j, (IMP/CON), in (1) is constrained equal across all industries, irrespective of the industry by which the good j is purchased, but our casual observations suggest that this assumption is not met in many cases.[3] Their definition also often excludes non-manufactured inputs.[4]

Second, as Yeats (2001) calculates from foreign trade statistics, the share of parts and components in total exports can be served as a measure of foreign outsourcing. The foreign outsourcing, however, could include processing of final products or trade in services and is not necessarily export of parts and components.

Thirdly, as excavated by Feenstra et al. (2000), under some special cases, such as U.S. offshore assembly programs, direct data of imported inputs, separated from domestic inputs, are

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[2] Hummels et al. (2001) calculate the imported input content of exports, defined by the share of exports in total output multiplied by imported intermediates. Anderton and Breton (1999) use imports from low-wage countries as a proxy for foreign outsourcing for U.K.

[3] This data limitation is true for U.S., but imported inputs are directly measured in some countries (Austria (Egger et al.(2001)), and Germany (Geishecker (2002), for example) and in OECD Tables used by Hummels et al. (2001) and others.

[4] Some studies use the share of purchased service as the outsourcing variable, although they do not distinguish international and domestic purchases. See Haskel (1999) for U.K. and Paul and Siegel (2001) for U.S., for example.

available.[5] Whether limited observations covered by these exceptional programs, however, can be a plausible representation of the whole national economy remains an issue.[6]

Finally, micro data for foreign outsourcing have so far been very few. All the previous studies cited above depend on industry-level data, but we must not neglect heterogeneity across firms in discussing foreign outsourcing because, as will be reported later, a large portion of firms are actually outsourcing none of their activities across national borders at all in the real world in spite of the growing opportunity for global transactions. As far as the author knows, Gorg and Hanley (2003), and Swenson (2000) are almost the sole contributions based on the foreign outsourcing data, explicitly distinguished from domestic outsourcing, at the micro level.[7] In both cases, however, the number of observation is relatively limited (less than one thousand firms), and their data are not intended to be a representation of the whole economy.

Before examining detailed firm-level data in the next section, a quick overview of the aggregate figures will be informative. Table 1 summarizes aggregate foreign outsourcing ratios of Japan, based on *Input-Output Tables*.[8] The column (1) shows that the foreign outsourcing seems to have become less active in Japan. While we must be cautious in international comparison, Campa and Goldberg (1997) reported that the foreign outsourcing ratio has increased in many countries. Table 1 provides us with some useful information by disaggregating inputs. First, as shown in the column (2), the decrease of foreign outsourcing, observed from aggregate total inputs, is largely due to the sharp decline in the share of energy

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[5] For example, Egger and Egger (2001) and Gorg (2000) used the inward/outward processing trade of EU. For Hong Kong, Hsieh and Woo (2000) use data of re-exports of goods imported from China after processed with intermediate inputs supplied by Hong Kong firms.

[6] According to Feenstra et al. (2000), the share of offshore assembly program imports in total U.S. imports during 1980-85 was from five to at most thirteen percent.

[7] No other firm-level outsourcing data used by previous studies have distinguished foreign from domestic outsourcing, including the data of 1070 Japanese manufacturers by Head and Ries (2002) or the firm-level data from three U.K. manufacturing sectors by Girma and Gorg (2002).

[8] The Input-Output Benchmark Tables for 2000 has not yet been published at the time of this research.

and material, most of which are imported in the Japanese case. Second, the foreign outsourcing continues to rise if we concentrate on manufactured inputs, as the column (3) of Table 1 demonstrates.[9] Hence, as in many other industrialized countries, the foreign outsourcing of manufactured products is actually increasing its importance in Japan.

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).[10] See Appendix for detailed description of the data. The survey includes various data at 1998, such as sales, capital, number of employees, value of foreign and domestic outsourcing, R&D spending, and industry classification.[11]

This survey is almost the unique source for the data of foreign outsourcing, distinguished explicitly from domestic outsourcing, sampled from large numbers of firms, covering all firm sizes without any threshold.[12] 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 asks "contracting out of manufacturing or processing to other firms[13]," which includes not only manufacturing of intermediate inputs, but also, basically any activities in the production processes, such as processing of products (e.g.

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[9] Why the import share declines in Japan's inputs of services is a topic worthwhile for an independent research.

[10] This paper focuses on manufacturing industries from the whole sample.

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

[12] Although it contains data on foreign outsourcing, the *Basic Survey of Business Structure and Activities* (Kigyo Katsudo Kihon Chosa in Japanese) covers only limited numbers of large firms (defined as those with more than fifty employees and capital of more than thirty million yen) and is not suited for evaluating the impact of foreign outsourcing on total Japanese manufacturing.

[13] This phrase in quotation is translated from the original questionnaire words of the survey. The word "gaichu" in Japanese literally means contracting-out. By definition, arms-length purchases of standardized components in the market are not included.

chemical/metal coating, slicing, smoothing), and final assembly. Thus, this survey is best suited for the studies of the fragmentation of production processes. Though outsourcing of non-production tasks is not included, this survey covers broader ranges of foreign outsourcing than by foreign trade data of parts and components.[14] The survey collects data in terms of yen values of contracts to firms located overseas and those to firms located inside the country separately, which this paper calls "foreign outsourcing" and "domestic outsourcing," respectively.[15]

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.

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 a wide range 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 activities across national boundary. Merely around two percent of our sampled 118,300 manufacturers are involved in foreign outsourcing, while nearly half of the firms experience outsourcing within the country.[16] Thus,

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[14] By this definition, basically any outsourcing of production processes may be included, though non-production, overhead services (e.g. cleaning, catering, and legal consulting) are not covered. Purchases of raw materials are captured by a different questionnaire, and thus excluded from here.
[15] 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.
[16] Firms with less than fifty employees are sampled with probability less than one in this survey. The government has not disclosed the sampling probability for different cells. The published aggregated statistics of this survey, after sampling adjustment, reports that 2.0% of all firms are involved in foreign outsourcing.

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 and inter-firm heterogeneity 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, for example, 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 remarkably low share of foreign outsourcing firms, however, does not mean that foreign outsourcing is unimportant from the following reasons. First, as shown in the table, the foreign outsourcing values more than four percent of total sales for the firm active both in domestic and foreign outsourcing, and nearly twenty percent for 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. Finally, the competitive or efficiency effect of foreign outsourcing is likely to spill over to other non-outsourcing firms through market interactions.

Second, 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. 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.

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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.[17] This gap may be consistent with the labor cost saving motivation for foreign outsourcing, but also suggests that higher technological or managerial capability is required to perform outsourcing across national borders.

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:[18]

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

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

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[17] 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.

[18] Girma and Gorg (2002) apply basically the same specification to firm-level outsourcing data, though they did not distinguish foreign from domestic outsourcing. Antras (1993) also estimates a reduced-form specification with almost the same explanatory variables for the intra-firm trade as the dependent variable at the country-industry level.

variables for two-digit industries, *DUM*, is also 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.[19] 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 involved in foreign 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 (2003).[20] The intuition behind this hypothesis is that only productive firms can choose foreign outsourcing because the outsourcing across borders entails high fixed costs. In our cross-section format, the positive sign for the coefficient on productivity is also expected when more active foreign outsourcing enables firms to concentrate on more innovative activities and results in higher productivity.[21]

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 communications by active use of e-mail communications, internet search, and digital

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[19] 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.

[20] 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.

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

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.[22] 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 investment in labor inputs.[23] 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, due to their high reputation or stronger bargaining power in the marketplace, larger firms may find foreign contracting partners more easily. On the other hand, however, larger

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[22] In a similar framework, Antras and Helpman (2003) 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. For example, Grossman and Helpman (2002) draw a different prediction by focusing on partial monitoring of efforts.

[23] 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.

firms may find more difficult to outsource their activities, as they are more likely to require higher quality or longer-term stable procurement.

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

$$\ln\left(1+\frac{FO}{DO}\right) = \alpha + \beta_1 \ln\frac{Q}{L} + \beta_2 \ln\left(1+\frac{PC}{Q}\right) + \beta_3 \ln\frac{K}{L} + \beta_4 \ln\left(1+\frac{H}{L}\right)$$
$$+ \beta_5 \ln\left(1+\frac{R\&D}{Q}\right) + \beta_6 \ln Q + \gamma DUM + u \tag{3}$$

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

The existence of firms without any outsourcing has so far been neglected. However, since around ninety-eight 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:[24]

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

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 first step, the above equation is estimated by the probit over all samples, including firms with no outsourcing. Then, in the second step, the equation (2) or (3) is

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[24] We have also confirmed that the principal results from the basic specification are robust even if we use maximum likelihood method with heteroskedasticity-consistent standard errors.

estimated by OLS on the selected sample (firms with strictly positive foreign outsourcing) with the inverse Mill's ratio λ estimated from (4). 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.[25] Since contracting with foreign firms requires searching for candidate firms in foreign countries, negotiating with potential partners in foreign languages, and concluding a contract with foreign firms in different legal systems, the firm is likely to be required at least some level of human skills.[26] However, the fixed entry costs for foreign contracting are likely to be substantially reduced if the firm has already had business experiences in foreign countries. As a measure of the firm's experience in foreign business, the dummy for foreign direct investment *FDI* is introduced (taking the value of one if the firm has at least one foreign subsidiary/affiliate, and zero otherwise).[27]

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 firms are outsourcing larger values of tasks to foreign firms than to other domestic firms when we focus on outsourcing firms. Combined with previously reported low share of foreign outsourcing firms in terms of the number of firms, these figures indicate that large-sized manufacturers are outsourcing relatively large value of activities across national borders once they decide to begin outsourcing. This

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[25] The human capital *H* is in logarithm. The principal findings of this paper remain basically robust even if all the explanatory variables in the second-stage regression are not excluded from the first-stage selection equation.

[26] Most of the main findings are robust even if the firm size in terms of sales is used instead of human skills.

[27] In defining FDI, all the foreign subsidiaries/affiliates are included, irrespective of the ownership shares.

observation appears consistent with high fixed costs for foreign contracting. Other figures in the same table 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 with the foreign outsourcing intensity. Though the positive sign is consistent with our prediction, we must wait for regressions simultaneously controlling for many factors. At the same time, also as expected, the human capital-labor ratio is relatively highly correlated with labor productivity.

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 Table 5. This indicates that we cannot ignore firms with no outsourcing in discussing the relationship between outsourcing and firm-level characteristics. In other words, any estimation results from samples excluding no outsourcing firms should be biased. In this sense, our comprehensive sample is suitable for our purpose. Since the inverse Mill's ratio is significant also in the regression with foreign vs. domestic outsourcing, 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, and consistent with our finding from descriptive summary statistics reported in the previous section, and also supports

the theoretical prediction by Antras and Helpman (2003).[28]

Third, more active use of computers is positively related with more extensive foreign outsourcing. Since more extensive use of computers tends to reduce communication costs, this finding is as expected. As this cost reduction effect of IT is found insignificant in the regression (3) on foreign vs. domestic outsourcing, 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. Therefore, firms producing more capital-intensive goods tend to be less active in foreign outsourcing. This result is favorable for the interpretation that the outsourcing of labor-intensive products is likely to be more attractive, compared with that of capital-intensive products, 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.[29] The same finding is also consistent with an alternative, widely held interpretation that foreign outsourcing from Japanese manufacturers, pressurized to cut high labor costs in Japan, tend to be concentrated in labor-intensive goods.[30]

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

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[28] If the quasi TFP is used, the coefficient is estimated not positive. This result is partly affected by the difficulty in measuring true productivity and the simultaneity in cross-section data, and by the correlation with the other explanatory variable *K/L*.

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

[30] Our cross-section data set cannot track the longitudinal aspect: rising capital-labor ratio as a result of active outsourcing of labor-intensive tasks.

column (2) of Table 5, the holdup problem appears more serious in contracts with foreign firms than with firms in the same country. Considering tremendous information imperfection across national boundaries, this finding is also 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.[31]

Sixth, as the negative coefficient on the firm size suggests, the foreign outsourcing ratio, relative to firm size and to domestic outsourcing, does not rise proportionally as the firm size becomes large. 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 human skill level and the experience of foreign business are found statistically significant.[32] These factors significantly affect the firm's decision whether or not he/she enters into the foreign outsourcing in the first place, as we expected.

We have also confirmed, though omitted from the table, that the main results reported here 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 positively related with the dichotomous selection of foreign outsourcing firms. Hence, 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.

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[31] 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.
[32] Even if other explanatory variables included in (2) or (3) are added to the selection equation (4), these two variables remain statistically significant.

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 foreign outsourcing, and also provides a new opportunity to directly test the theoretical hypothesis derived from the microeconomic incomplete contract model. Our sample demonstrates that around 98 percent of the firms are not involved in any foreign outsourcing at all. Motivated by this remarkably low share of foreign outsourcing firms, this paper examines the relationship between the firm's choice of foreign outsourcing and various firm-level characteristics within the framework of Heckman's two-step estimation. The regression results show that higher productivity, more active use of computers, and lower capital-labor ratio are positively related with more extensive foreign outsourcing. Foreign outsourcing firms are selected by the firm's human skills and foreign business experience.

As a final note, we need to further check the robustness of these results, since they are based only on Japanese data. As far as we know, however, no other firm-level data measuring foreign outsourcing, distinguished explicitly from domestic outsourcing, with comprehensive coverage of industries of the entire country, are currently available. In this sense, 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 based on the access to original micro-data files, allowed by the Ministry of Public Management as No. 428. This survey was conducted only once in 1998. As long as I have confirmed by interviews with the staffs, the government has no plan to continue this survey, at least in the same format.

The survey is designed to cover firms in all sizes. Although the survey is not a census, the sample is designed 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 data used for our analysis are as follows. The employment (L) is "total regular employees (Answer No. 4)" in the 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 in the survey, this paper uses "sales and general administration (SGA) expenses" (No.20) 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 including 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

Japan's foreign outsourcing at the aggregate level

YEAR	(1) All inputs	(2) Excluding energy and materials	(3) Manufactured inputs
1980	10.76	4.83	4.99
1985	9.06	4.80	5.37
1990	7.38	5.13	6.03
1995	6.28	4.76	6.23

Notes: Shown are the percentage shares of imported inputs for total manufacturing, based on Japan's *Input-Output Benchmark Tables*, various issues.

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 the dummy variables, are in logarithm.