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

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Current version: April 27, 2004

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### **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. Merely around two percent of the firms are outsourcing their production across national borders. The fixed entry costs for foreign outsourcing is significant, and appears negatively 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<sup>1</sup>, 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.<sup>2</sup>

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, theoretical models of foreign outsourcing have recently been constructed based on the incomplete contract theory by a series of papers, including Antras

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<sup>1</sup> 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. Our definition will be explained in the next section.

<sup>2</sup> 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 and future projections. For an overview, see Drezner (2004), for example.

(2003) and Grossman and Helpman (2002). Interesting hypotheses on the relationship between foreign outsourcing and characteristics of firms have been derived from these formal models. Direct firm-level empirical tests of these 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, in production processes at the firm level, from a large sample representing the whole manufacturing in a country.<sup>3</sup> 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 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 merely around two percent of the firms are outsourcing parts of 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 appears negatively related with the firm's human skills (or firm size) and foreign business experiences. Our regression estimates demonstrate that more productive firms tend to be more active in foreign outsourcing. Also as consistent with a theoretical prediction, this paper 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.

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<sup>3</sup> As will be discussed in the next section, there exist 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.

## 2. Data description

### 2.1. Alternative measures of foreign outsourcing

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

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

, 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.<sup>4</sup> 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.<sup>5</sup> Their definition also often excludes non-manufactured inputs.<sup>6</sup>

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.

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<sup>4</sup> 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.

<sup>5</sup> 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))).

<sup>6</sup> The share of purchased service is also used as an outsourcing measure, though foreign and domestic purchases are not distinguished. For example, Haskel (1999), and Paul and Siegel (2001).

Third, 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 available.<sup>7</sup> Whether limited observations covered by these exceptional programs, however, can be a plausible representation of the whole national economy remains an issue.<sup>8</sup>

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 contributions based on the foreign outsourcing data, distinguished from domestic outsourcing, at the micro level.<sup>9</sup> 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*.<sup>10</sup> 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 reveals 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 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.<sup>11</sup> Hence, as in

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<sup>7</sup> Egger and Egger (2001) and Gorg (2000) used inward/outward processing trade data of EU.

<sup>8</sup> 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.

<sup>9</sup> 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).

<sup>10</sup> The Input-Output Benchmark Tables for 2000 has not yet been published at the time of this research.

<sup>11</sup> Why the import share declines in Japan's inputs of services is a topic worthwhile for an independent research.

many other industrialized countries, the foreign outsourcing of manufactured products is actually increasing its importance in Japan.<sup>12</sup>

## 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).<sup>13</sup> 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 includes various data at 1998, such as sales, employment, value of foreign and domestic outsourcing, and industry classification.<sup>14</sup>

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.<sup>15</sup> 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.<sup>16</sup>” The data in terms of million yen values of contracts to firms located overseas are collected separately from those to firms located

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<sup>12</sup> 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.

<sup>13</sup> 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.

<sup>14</sup> Many other variables, such as the number of computers, are covered in the survey, though some data related with our topics, such as ownership shares, are not collected.

<sup>15</sup> 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.

<sup>16</sup> The quoted phrase is translated by the author from the questionnaire of the survey.

inside the country, which this paper calls “foreign outsourcing” and “domestic outsourcing,” respectively.<sup>17</sup> Since basically any activities in the production processes are included, such as procurement of specialized components, processing of products (e.g. coating, slicing), and final assembly, 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 included, though broader ranges are covered than by foreign trade data of parts and components.<sup>18</sup> Second, contracting-out to partly-owned subsidiaries are not separated in the outsourcing, as the survey asks firms to report all contracts with independent legal entities but no ownership data are required. Third, arm’s-length purchases of standardized components in the market 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.”<sup>19</sup> The survey does not ask whether or not the outsourced task was previously accomplished inside the firm. 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 covered by our measure if the firms are no longer classified as manufacturers due to their active outsourcing in the past.<sup>20</sup> While we must

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<sup>17</sup> 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.

<sup>18</sup> Purchases of raw materials are covered by a different questionnaire, and thus excluded from here. The *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.

<sup>19</sup> The quoted phrase is translated by the author from the glossary appendix of the published report. In the survey, the purchase of components is captured as a part of expenses on materials.

<sup>20</sup> This firm status change seems not prevalent in most sectors, but without exceptions. The published statistics from the same survey report that nearly seven percent of wholesalers in textiles/apparels are outsourcing overseas, and their foreign outsourced manufacturing/processing

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

### **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 boundary. Merely around two percent of our sampled 118,300 manufacturers are outsourcing their production overseas, while nearly half of the firms experience outsourcing within the country.<sup>21</sup> 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, for example, communications in different languages, and adjustments across different legal systems.<sup>22</sup> 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.

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tasks value much larger than those by manufacturers in the same industry.

<sup>21</sup> Firms with less than fifty employees are sampled with probability less than one in this survey. The sampling probability for different cells was not disclosed. The published aggregated statistics, after sampling adjustment, reports that only 2.0% of all firms are involved in foreign outsourcing.

<sup>22</sup> Only six percent of outsourced tasks are contracted out to foreign firms in our sample.

This 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.<sup>23</sup> 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 countries surpasses the value of material imports in Japanese manufacturing.<sup>24</sup> Besides, as was mentioned previously, our count of foreign outsourcing firms excludes firms outsourcing non-production services or purchasing intermediates from marketplace, and “wholesalers” outsourcing production tasks. 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.<sup>25</sup> 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

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<sup>23</sup> The aggregate statistics from the survey show that foreign outsourcing values less than one percent of total sales if large-numbers of no outsourcing firms are combined.

<sup>24</sup> This survey shows that aggregate foreign outsourcing value is larger than the direct imports of materials in total manufacturing. The Input-Output Tables, used for Tables 1, also show that manufactured intermediates occupy larger share than materials/energy in Japan’s total imports.

<sup>25</sup> 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.

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.<sup>26</sup> 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 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:<sup>27</sup>

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

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

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<sup>26</sup> 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.

<sup>27</sup> 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) uses almost the same explanatory variables for the intra-firm trade regressions at the country-industry level.

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.<sup>28</sup> 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 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).<sup>29</sup> 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 extensive foreign outsourcing enables firms to concentrate on innovative activities and results in higher productivity.<sup>30</sup>

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

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<sup>28</sup> 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.

<sup>29</sup> 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.

<sup>30</sup> 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.

quick communications by active 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.<sup>31</sup> 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.<sup>32</sup> 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

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<sup>31</sup> 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. Grossman and Helpman (2002) 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.

<sup>32</sup> 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 foreign contracting partners more easily. On the other hand, however, larger 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.

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

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 in our empirical specification.<sup>33</sup> 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:<sup>34</sup>

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

where  $\Phi$  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

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<sup>33</sup> 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.

<sup>34</sup> 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.

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.<sup>35</sup> 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 are necessary.<sup>36</sup> 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  $FDI$ .<sup>37</sup>

#### 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 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.

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<sup>35</sup> 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.

<sup>36</sup> Most of the main findings are robust even if the firm size is used instead of human skills.

<sup>37</sup> 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.

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  $\lambda$  is statistically significant at any conventional significance levels in all cases reported in Table 5. 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, 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 (2003).<sup>38</sup>

Third, more active use of computers is positively related with more extensive foreign outsourcing. As this communication 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. In other words, firms producing labor-intensive goods tend to extensively outsource their activities.

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<sup>38</sup> If the quasi TFP is used, the coefficient is estimated not positive. This result is partly affected by the simultaneity in cross-section data, and by the correlation with the other explanatory variable  $K/L$ .

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.<sup>39</sup> 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, tend to be concentrated in labor-intensive goods.<sup>40</sup>

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 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.<sup>41</sup>

Sixth, as the negative coefficient on the firm size suggests, the foreign outsourcing ratio 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

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<sup>39</sup> The industry-country level regressions by Antras (2003) failed to detect the significant effect of human capital, though physical capital was found significant.

<sup>40</sup> 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.

<sup>41</sup> 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.

significant.<sup>42</sup> These factors affect the firm's decision whether or not he/she enters into the foreign outsourcing in the first place.<sup>43</sup> 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. 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.

## 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, around 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. More extensive outsourcing across national borders tends to be observed in the firms whose productivity is higher or whose products are more labor-intensive. These findings are consistent with theoretical predictions, and contribute to our quantitative understanding of international production fragmentation, while we must be cautious in evaluating numbers because of the data limitations. Among other things, we will in the future need to seek other data sources for the outsourcing of

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<sup>42</sup> Even if other explanatory variables included in (2) or (3) are added to the selection equation (4), these two variables remain statistically significant.

<sup>43</sup> Our foreign outsourcing variable includes contracts with foreign subsidiaries unless those contracting partners are wholly owned. However, the number of firms outsourcing across borders is far larger than that of firms possessing wholly-owned foreign subsidiaries.

non-production services, as it is supposed to be rapidly increasing and currently attracts wide attention.

As a final note, we will have to further check the robustness of these results, since they depend only 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 its large number of small-sized firms, who are less likely to be involved in outsourcing across borders.<sup>44</sup> 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.

### **Acknowledgements**

The Ministry of Public Management allowed the author to have access to original micro-data files in the government of Japan by No. 428 on July 22, 2002. The author appreciates helps for this data access, especially by Kazuyuki Motohashi and Junko Sakamoto. The author acknowledges valuable comments from participants of the seminar/meeting at the University of Michigan, University of Hawaii, and Yokohama National University. Various supports from University of Hawaii, especially Theresa Greaney, during my stay as a visiting scholar are also appreciated. The research for this paper is partly financed by Center for Global Partnership of Japan Foundation, the Grant-in-Aid for Scientific Research (Nos. B14330012, C13630056, and C16530152), 21<sup>st</sup> Century COE Grant by the Ministry of Education and Science, Japan Economic Research Promotion Foundation, and Rokko-dai Koen-kai of Kobe University. All remaining errors are mine.

### **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 files on manufacturing firms in the survey, 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, the government has no plan to continue this survey in the

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<sup>44</sup> This U.S.-Japan difference in industrial organization was pointed out by Prof. Gary Saxonhouse.

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 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
<i>Number of Firms</i>	2,929	234	55,032	60,105
<i>Employment</i>	447	104	81	37
<i>Sales</i>	24,689	8,150	3,018	1,176
<i>Productivity</i>	28.69	30.65	20.99	15.63
<i>H/L</i>	5.25	5.86	4.37	3.82
<i>R&amp;D/Q</i>	2.49	2.59	2.37	3.48
<i>R&amp;D/L</i>	0.830	0.641	0.526	0.527
<i>PC/L</i>	0.218	0.200	0.161	0.086
<i>PC/Q</i>	9.53	11.80	10.19	9.07
<i>K/L</i>	7.76	7.73	6.60	6.75
<i>FO/Q</i>	4.07	19.67	0	0
<i>DO/Q</i>	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
<i>FO</i>	3,163	898.5	12672.3
<i>DO</i>	57,961	723.7	19087.5
<i>Q</i>	118,300	2629.1	45975.8
<i>L</i>	118,300	67.8	620.2
<i>K</i>	96,515	992.7	14520.4
<i>H</i>	118,300	445.2	7833.2
<i>R&amp;D</i>	19,314	459.0	7595.7
<i>PC</i>	113,945	21.7	527.5
<i>FDI</i>	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

	<i>FO/Q</i>	<i>Q</i>	<i>Q/L</i>	<i>K/L</i>	<i>H/L</i>	<i>R&amp;D/Q</i>	<i>PC/Q</i>	<i>FDI</i>
<i>FO/Q</i>	1							
<i>Q</i>	-0.005	1						
<i>Q/L</i>	0.139	0.210	1					
<i>K/L</i>	-0.001	0.104	0.275	1				
<i>H/L</i>	0.110	0.190	0.576	0.254	1			
<i>R&amp;D/Q</i>	0.014	0.221	0.075	0.059	0.161	1		
<i>PC/Q</i>	-0.060	0.009	-0.158	-0.051	-0.035	0.252	1	
<i>FDI</i>	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) <i>FO/Q</i>	(2) <i>FO/DO</i>	(3) <i>FO/Q</i>	(4) <i>FO/Q</i>	(5) <i>FO/Q</i>
<i>Productivity</i>	0.0385 (0.0036)	0.1583 (0.0256)	0.0370 (0.0035)	0.0289 (0.0028)	0.0378 (0.0035)
<i>Computers</i>	0.2784 (0.0993)	-0.0550 (0.8773)	0.2325 (0.0990)	0.2499 (0.0997)	0.3138 (0.0977)
<i>K/L</i>	-0.0037 (0.0014)	-0.0127 (0.0098)	-----	-0.0038 (0.0014)	-0.0036 (0.0014)
<i>H/L</i>	-0.0146 (0.0034)	-0.1163 (0.0243)	-0.0140 (0.0034)	-----	-0.0136 (0.0034)
<i>R&amp;D</i>	0.1386 (0.0720)	0.2460 (0.5079)	0.1402 (0.0608)	0.0901 (0.0713)	-----
<i>Firm size</i>	-0.0178 (0.0017)	-0.0881 (0.0129)	-0.0186 (0.0017)	-0.0148 (0.0015)	-0.0175 (0.0017)
$\chi^2$	572.55	277.13	595.95	554.88	567.87
Selection Eq. <i>H</i>	0.1548 (0.0049)	0.1649 (0.0051)	0.1480 (0.0048)	0.1548 (0.0049)	0.1548 (0.0049)
<i>FDI</i>	0.7076 (0.0251)	0.6544 (0.0260)	0.7065 (0.0250)	0.7076 (0.0251)	0.7076 (0.0251)
Inverse Mill's ratio	-0.062 (0.007)	-0.416 (0.051)	-0.061 (0.007)	-0.051 (0.006)	-0.063 (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.