Exploring Determinants of the Firm Boundary for Swedish Multinationals

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Exploring Determinants of the Firm Boundary for Swedish Multinationals*

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ABSTRACT

This paper empirically examines the foreign internalisation decision of multinational corporations. The purpose of the paper is to identify determinants of the firm boundary, where within-boundary production takes the form of foreign direct investments (FDI) and outside-boundary production takes place through international outsourcing, with reference to recently developed general-equilibrium trade theories incorporating firm behaviour. The empirical investigation is performed for 2246 multinationals production engagements in 148 foreign countries under the 1997 to 2006 period. The primary contribution of the paper is the investigation of firm behaviour *per se* instead of industry level implications of firm behaviour.

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INTRODUCTION

International trade researchers have recently placed focus on the impact of within-industry firm heterogeneity on general-equilibrium outcomes.[1] One strand of this literature, represented by Antràs and Helpman (2004, 2008) and Grossman and Helpman (2004), formalises the foreign internalisation decision of firms by investigating the two-dimensional firm choice of organisational form (integration/outsourcing) and input source location (North/South). The purpose of this paper is to draw upon these reference models to empirically examine determinants of the firm's foreign internalisation decision.

In coherence with our reference models, a unified empirical approach is used to examine alternative combinations of the firm's choice of organisational form and input source location. The theories underlying this study indicate that individual firm behaviour can affect the international production and trade pattern at the industry level. Since this implies that firm behaviour can impact on the international specialisation of production and may have strong welfare implications, it is of interest to investigate whether the firm behaviour that is observed in practice is predicted by the novel trade theories. This paper is focused on the behaviour of multinational enterprises (MNEs). These firms tend to be the largest and most productive enterprises and are thereby likely to contribute the most to explaining individual firm effects on industry outcomes.

It is a well-established fact that multinational firm activity can be explained by a combination of localisation factors from international trade theory and factors capturing the internalisation decision of the firm within the industrial organisation literature (as first synthesised by Dunning, 1988). Our reference theories provide formalisations of the foreign internalisation choice that are consistent with standard trade theoretic modelling tools and heterogeneous firm behaviour in forms stipulated by industrial organisation researchers. These models thereby provide a suitable theoretical basis for our empirical investigation.

The previous empirical studies that examine the same reference models, Yeaple (2006) and Nunn and Trefler (2008), investigate the effects of firm behaviour on industry-level trade outcomes. In contrast to these contributions, the purpose of this paper is to empirically identify determinants of the firm's foreign internalisation choice *per se*. The novelty of our empirical contribution thereby lies in providing direct evidence of actual firm behaviour. Previous empirical studies in the field are based on the assumption that a direct link exists between the productivity level and size of a firm. This assumption is not validated by our data, indicating that it is imperative to perform a firm level investigation to properly

assess the model predictions of firm behaviour. Another major difference between this paper and previous studies in the research field is our investigation of Swedish (and not US) firms.

To enable a direct comparison of the effect of each determinant on the firm's two-dimensional foreign internalisation decision, probit regressions are run for the alternative choice combinations of organisational form and input source location. The empirical approach allows us to perform ranking tests of the self-selection pattern of firms into behavioural categories. A clarification of this pattern is informative and could fertilise future theoretical research developments, so we choose to provide the ordering of firm behaviour with respect to each determinant as part of our empirical investigation.

The rest of the paper is organised as follows. The next section provides an overview of the integration and outsourcing decisions of firms in our sample. A theoretical background is presented in section 2 to introduce the economic underpinnings of the firm's foreign internalisation choice. In section 3, the paper's empirical approach is described. The estimation results are examined in section 4. Section 5 investigates the self-selection pattern of firms is with respect to each determinant. A concluding discussion of our main results is provided in the last section of the paper.

I. THE FDI AND OUTSOURCING DECISIONS OF SWEDISH MNES

This section provides an overview of the FDI and outsourcing decisions underlying our empirical examination, which can be useful before continuing with the analysis. The firm level data used in this paper contains detailed information of the enterprise's Swedish production characteristics. In the underlying theories, these firm characteristics properly capture determinants of the firm's two-dimensional foreign internalisation choice. The firm-level data used in this paper conssits of annual observations in the 1997 to 2006 period.

A firm with at least one foreign employee is classified as a multinational enterprise in our data and the Swedish designation requires a Swedish firm ownership of at least 50 percent. The data set is suitable for investigating the firm's foreign internalisation decision as there is no downward restriction on neither the firm size nor the foreign direct investment of the firm.

Our sample includes all Swedish multinational corporations in the manufacturing industry, which adds up to a total of 2246 MNEs in the investigated time period. There is a large variation in firm behaviour across time and (geographical) space that can be attributed to mergers and (temporary or permanent) firm exits from the market. The sample includes 148 foreign countries and, in coherence with the underlying theories, it is divided into a North

sample consisting of OECD countries and a South sample containing non-OECD members. The sample division is consistent with the North and South country specification that is standard in the international trade literature, which depicts rich nations with relatively well-developed welfare systems as part of the North and the remaining countries as part of the South. The data shows that most production activities taking place within the firm boundary are located in the North: The sample contains more than twice as many observations of affiliate production in the North as in the South.

The standard measure of international outsourcing equals the share of imported intermediate inputs divided by firm sales.[2] This measure captures so-called "broad" outsourcing in contrast to "narrow" outsourcing, which is identified in terms of imports of intermediates in the firm's own industry. Due to data limitations, we are inhibited from constructing any narrow form of this measure. All firms entering the sample are active producers with positive sales, so the dichotomous choice of outsourcing production can be identified from import data on intermediate inputs.

A drawback of the data is that an observational equivalence exists for observations depicting simultaneous FDI and outsourcing decisions. Due to lack of information of whether trade is intra-firm in character, these observations can capture the simultaneous sourcing of inputs from affiliated and independent suppliers as well as the sole purchase of inputs from affiliated producers. Bernard et al. (2006) provide product-level evidence of that MNEs may be engaged in simultaneous FDI and outsourcing activities in the same location. This is what Yeaple (2003) refers to as the "complex integration strategies" of multinational corporations. If some outsourcing observations in our sample capture production that only takes place within the firm boundary, the presence of this measurement bias will reduce the estimation discrepancies due to differences in organisational form. The systematic discrepancies between the FDI and outsourcing estimation results may therefore understate the actual differences in firm behaviour.

The country origin of imports is reported for all countries that are not members of the European Union. Because of the standard EU trade classification, Swedish import data from other EU countries is not reported by country origin and can thereby contain trade for which the country only serves as a transit location. Due to this measurement error problem, the robustness of the estimation results for the North sample is checked against estimation results for a reduced sample excluding foreign EU countries. The strong Northern bias described for the firms' FDI decisions persist in examining their outsourcing choices. Outsourcing activities

are at least twice as prevalent in the North as in the South (and more frequent if observations for foreign EU members are taken into account).

II. THEORETICAL BACKGROUND

This section contains a description of the theoretical relationships underlying the firm's foreign internalisation decision in our reference models. A common feature of these models is that the product completion of a final good requires an established and functioning relationship between the final good producer (the firm) and the input provider. The firm can choose integration or outsourcing as its organisational form and due to imperfect contract enforcement (with the property rights approach) or imperfect opportunities to monitor the input provider (with the incentive systems approach), the firm incorporates the behaviour of the input provider into its profit-maximising choice of organisational form. This behaviour impacts on the level or quality of the firm's input supply in our reference models.[3]

The profit maximisation of the firm also depends on its choice of input source location. The firm's part of the production process is located in the North and it can choose to purchase inputs from the North or South. The Southern location advantage takes the form of lower variable input unit costs or lower total input unit costs while the Northern location advantages are based on lower fixed (organisational) costs of production, a better contract enforcement environment and/or improved monitoring opportunities. The firm's choice of organisational form and input source location is simultaneous and, since firms are heterogeneous, there can be a variation in the foreign internalisation choices of firms within the same industry.

Antrás and Helpman (2004, 2008) provide the reference models that use a property rights approach in explaining the foreign internalisation choice of the firm. The property-rights approach depicts that the profit maximisation of the firm depends on its boundary because of incomplete contract enforcement. There is imperfect contracting due to the precise nature of the required input, which cannot be verified by a third party, is *apriori* unknown. This specification of the contracting environment, which is supported by the theoretical evidence provided by Hart and Moore (1999) and Segal (1999), prevails under both integration and outsourcing. The parties need to make relationship-specific investments to set up mutual production chains. As contracts cannot be perfectly enforced, there is a hold-up problem between the parties and the individual returns from the producer relationship is determined through *ex post* Nash bargaining. Each party owns assets required to perform their

individual stage of the production process, implying that the sunk investment put down by each party in creating the relationship determines his outside option in the bargaining game.

The incentive systems approach depicts that the profit maximisation of the firm depends on its boundary because the firm's monitoring of the input provider's efforts is imperfect and costly. Grossman and Helpman (2004) provide the reference model utilising an incentive systems approach in explaining the firm's foreign internalisation decision. In their model, the firm's monitoring of the input provider's performance is imperfect under both integration and outsourcing. Monitoring opportunities are improved when input provision takes place within the ownership of the firm, which favours integration over outsourcing. But the firm pays the setup cost of input production under integration, thereby reducing the efforts extracted from the input provider. The firm's organisational choice therefore reflects a trade-off between its improved monitoring opportunities with integration and the input provider's raised incentives to perform well with outsourcing.

The firm's productivity level is determinant of its foreign internalisation decision in all our reference theories. Input production takes place at lower variable input unit costs in the South. In Antràs and Helpman (2004, 2008), the Southern cost advantage is counteracted by lower fixed costs and/or a better contract enforcement environment in the North. Only the most productive firms benefit from paying the higher cost of establishing a relationship with an input provider in the South in Antràs and Helpman (2004) and from reducing the number of contractible tasks by engaging an input provider in the South in Antràs and Helpman (2008). This self-selection pattern of firms hinges on the fact that the most productive firms acquire the largest market shares enough sales, which lets them benefit the most from the Southern cost advantage.

Grossman and Helpman (2004) formalises the Northern cost advantage in the form of improved monitoring opportunities as the input production takes place in closer proximity to the firm. In their model, the firm's need to extract efforts from the input provider results in a self-selection pattern where the most and least productive firms source their inputs from the South. Since the rationale behind this firm decision is closely interlinked with the firm's integration and/or outsourcing decision, it is described further below.

In Antràs and Helpman (2004, 2008), the fixed cost of setting up affiliate production in a country is higher than that of contracting an independent supplier in the location. These models are general with outcomes depending on the industry's relative headquarter intensity. The scenario described here is the one resulting in industries with a relatively high headquarter intensity of production (for which the choice of within-boundary production is a

viable alternative). Under this condition, the firm receives a relatively large fraction of the surplus generated by a successful relationship between the parties. This outcome of the bargaining game reflects that the assets owned by the firm contribute the most to the surplus of the producer relationship. The firm's surplus fraction is larger with integration than outsourcing, which impacts positively on its revenues. However, these revenues are high enough to compensate for the higher fixed cost of integration only if the firm is sufficiently productive. The basic explanation of this outcome is that there is a direct link between the productivity level and size of the firm, with a higher productivity level yielding higher market shares by assumption. This implies that, amongst firms that source inputs from the same location, those that are more productive will choose to internalise their input provision.

The sorting pattern of firms into behavioural categories hinges on the North-South cost differential (in variable input unit costs). If the differential is small enough, the firm ranking with respect to firm productivity equals $OUT_N < FDI_N < FDI_S$, where *FDI* and *OUT* denotes the firm's integration and outsourcing decision and *N* and *S* depicts North and South country locations. If the cost differential is sufficiently large, the sorting pattern of firms with respect to their productivity levels instead equals $OUT_N < FDI_N < OUT_S < FDI_S$.

In Grossman and Helpman (2004), low-productivity firms source their inputs from the South to take advantage of the lower input unit costs in that location. The least productive firms outsource their input production to induce more efforts from the input provider. The input provider's increased incentive to perform well with outsourcing is explained by the fact that he has to invest the set-up costs of input production and thereby incurs a larger loss if the relationship fails. Firms in the higher low-productivity range choose to internalise their input production as there are relatively large gains from monitoring at higher revenue levels. For the same reason, firms with intermediate productivity levels insource their input provision. In their case, however, the benefit of better monitoring opportunities at closer proximity to the firm outweighs the higher input unit costs in the North.

High-productivity firms outsource their input production because rent sharing is required to induce the best performance from the input provider and the rent paid out for input provision is lower for an independent supplier compared to a hired manager (because the set-up costs of input production serves as a tax on these rents). In addition, these firms choose Southern input source locations due to their lower input production costs. The Grossman and Helpman (2004) model's predicted self-selection pattern of firms with respect to firm productivity thereby equals $OUT_S < FDI_S < FDI_N < OUT_S$.[4]

III. EMPIRICAL APPROACH

Our reference theories predict that the firm choice of organisational form and input source location depends on a set of factors that jointly determine its expected profits. Of particular interest from an empirical perspective are the behavioural effects of the firm's productivity level and the legislative quality in the foreign country. Though the incentives systems approach predicts that the foreign internalisation decision of the firm depends on the proximity of the firm and the input provider, standard proximity variables capturing the transaction costs of monitoring (i.e. direct and indirect travel and communication costs) are highly correlated with international trade costs in practice. This indicates that no direct support for the incentives systems approach can be inferred from the statistically verified effect of proximity variables on firm behaviour. For this reason, direct proximity measures are exempted from our empirical investigation.

The reference theories that use a property-rights approach predict that the firm's contractual enforcement environment is better in the North than in the South. While the Antrás and Helpman (2004) model indicates that improvements of the legislative quality in a country always benefits a firm's decision to outsource its input production to the location, the result is replicated in the Antrás and Helpman (2008) model only if the reduced contractual imperfections primarily affect the firm's side of the producer relationship. The latter outcome is the consequence of that the firm's bargaining share of the surplus created by the relationship decreases (increases) with the contractibility of headquarter (input production) activities. This study lacks sufficiently detailed data to investigate the differential impact of each country's legislative quality on the two sides of a typical contracting relationship. We therefore settle for investigating the on-average impact of the foreign legislative quality on the firm's foreign internalisation choice.

Our empirical model incorporates firm-specific bilateral trade composition variables to account for any trade theoretic explanation (whether based on international differences in production technologies, factor endowments or market sizes) that may underlie the MNE's choice of input source location(s). This general trade theoretic approach is suitable given the large sample variation in foreign country characteristics.

Two additional determinants are included in the empirical model on the basis of their empirical relevance. These factors play a central role for the firm's choice to engage in foreign direct investment or outsourcing activities in the research fields specialized on these topics. A consistent theme in the FDI literature, starting with early studies such as Dunning (1958) and Hymer (1960), is the view that the firm's internalisation of production hinges on

the existence of firm-specific technology. The argument behind this view is that firms with more advanced technologies prefer to set up affiliate production units to protect their knowledge-based assets from outside competitors. Antràs (2005) has introduced this factor as a determinant of the firm's foreign internalisation choice in a general-equilibrium trade model. His model is however not directly applicable to our empirical investigation as it relies on the simplifying assumption of representative firms.

In the outsourcing research area, the firm choice of contracting an independent supplier depends on the "market thickness" of suppliers in the country, capturing that lower transaction costs are encountered in finding a suitable business partner in more well-established input markets.[5] Grossman and Helpman (2005) have formalised the effect of this determinant on the foreign internalisation decision of the firm in a general-equilibrium trade model based on representative firms.

A probit model is used to explain the firm choice of organisational form and input source location. Since our sample is unbalanced in ways that are neither stochastic nor easily predicted, we abstain from using panel data methods. Time, industry and location dummies are included in the model on the basis of Wald tests.

Our probit model depicts the probability that a firm purchases inputs from an independent or affiliated supplier in a particular location in a given time period. *ORG* denotes the dichotomous choice of organisational form, which takes the form of foreign affiliate production (*FDI*) or outsourcing (*OUT*).

The empirical model equals:

$$\text{Prob}(\text{ORG}_{ijkt} = 1) = \Phi(\alpha_j D_j + \alpha_k D_k + \alpha_t D_t + \beta_1 VAPE_{it} + \beta_2 RCIPE_{it} + \beta_3 SALES_{it} + \beta_4 SST_{it} + \gamma_1 MATH_{jkt} + \sigma_1 IMPS_{ikt} + \sigma_2 EXPS_{ikt} + \delta_1 QL_{kt}),$$

where the *i*, *j*, *k* and *t* subscript denotes the firm, industry, location and time period, Φ depicts the standard normal distribution, *D* denote dummy variables, *VAPE* is the firm's productivity level as measured by its value added per employee, *RCIPE* is the firm's real capital investment per employee (which is a control variable included to clear the productivity measure from investment effects), *SALES* is the firm size as measured by its total sales, *SST* is the specificity of the firm's production technology as measured by the share of technicians in its work force, *MATH* is the foreign market thickness of input suppliers, *EXPS* is the firm's bilateral export share, *IMPS* is the firm's bilateral import share and *QL* is a variable capturing the foreign quality of legislation.

As previously described, a firm is identified as having affiliate production in a foreign country if it has at least one employee in that location. While input sourcing is the only rationale for *FDI* in our reference theories, another reason for the existence of foreign direct investment is that production units are placed in foreign countries that functioning as export platforms.[6] To the extent that the firm choice of input source location is driven by trade theoretic factors, this rationale for FDI may be reflected in the firm's export share to the foreign country. We will return to discuss this feature in presenting the estimation results.

For reasons explained in the paper's first section, a firm is identified as outsourcing production to a foreign country if it imports intermediate inputs from that location. Industry categories are identified by the standard Swedish industry classification, SNI, at the 2-digit aggregation level.[7] The *VAPE*, *RCIPE* and *SALES* variables are based on inflation-adjusted data reported in thousands of Swedish crowns and are measured in natural logarithms.[8] The *MATH* variable is approximated by the total intermediate input imports of Swedish MNEs in the industry. All firm data used in this study comes from the Institute for Growth Policy Studies.

The *QL* variable is measured by the rule of law governance indicator provided by the World Bank. The rule of law indicator is constructed to capture the aggregate legislative quality in a country by comprising several quality aspects of the legislative system into a common index. For instance, the indicator includes measures of organised crime, the enforceability of contracts, intellectual property rights protection and the risk of private property confiscation. The rule of law measure is based on a number of reliable sources, including reports and surveys from the World Bank, the World Economic Forum and Gallup International. (These sources and the legislative quality aspects included in the rule of law indicator are listed in this paper's appendix.)

To comprise information obtained from various sources into one index value, the rule of law measure is constructed using an unobservable components model. This implies that the index construction relies on the basic assumption that coherent observations from different sources contain true information and a more precise index value therefore is based on the correlation of underlying variable values. (Kaufmann et al., 2004, provide a detailed description of the unobserved components model approach used in constructing the World Bank government indicators.) The governance indicators are freely available at the designated World Bank website.[9] To add transparency to our analysis, the *QL* variable is a recalculated version of the rule of law indicator lying in the zero to one interval. For the *QL* variable, a higher variable value indicates a better legislative quality.

Table 1 here

Table 1 provides summary statistics of the decision and explanatory variables reported by country sample. As can be seen from the table, similar statistics are provided for the reduced and full North sample. A notable difference can however be observed for the *MATH* variable, which has a larger mean value when EU observations are included in the sample. This discrepancy is likely to reflect an upward bias in the outsourcing estimates that is due to the (previously described) reporting error on intra-EU trade.

The summary statistics of the *VAPE* and *SST* variables are almost identical across country samples, which suggest that a Swedish MNE typically fragments its production by making simultaneous input purchases from different locations. The main discrepancies in summary statistics across samples prevail for the *OUT*, *MATH* and *QL* variables. As can be seen from table 1, the mean values of these variables are all considerably higher in the North than in the South. These mean value differentials display the existence of a higher outsourcing frequency, a thicker market of input producers and a better legislative quality in Northern compared to Southern locations.

Table 2 here

In table 2, correlation matrices are presented by simple correlation coefficients between variable pairs for each country sample. The correlation figures provided for the reduced and full North sample are similar in terms of signs and sizes with one exception. The simple correlation coefficient between the *IMPS* and *SALES* variable is positive only when EU countries are included in the North sample, possibly reflecting that Swedish firms can reduce their production costs (and thereby charge lower prices) due to low prices on imports from other members of the customs union. As can be seen from the table, there are often notable differences in the correlation figures obtained for the North and South samples. Considering the relatively low correlations that exist between the determinants, the estimation of our empirical model does not appear to be affected by any severe multicollinearity problems.

IV. ESTIMATION RESULTS

The empirical model is estimated using a maximum likelihood method and marginal effects of the parameter estimates, which capture the direct effect of each determinant on the dependent variable, underlie our empirical investigation. The reported parameter estimates of dummy variables equal the estimated probability change resulting from a zero to one variable alteration. The estimation results are reported in table 3.

Table 3 here

The empirical model performs well when put to data: The likelihood ratio indices are of reasonable magnitude across estimations and most parameter coefficients are statistically different from zero at the one percent level. Time, industry and location dummies are included in all estimations based on Wald test results. A glance at table 3 reveals that the firm's foreign direct investment and outsourcing decision to the North and South mostly is explained by the same set of determinants. The estimated parameter coefficients often differ depending on the firm choice of organisational form and input source location, thereby providing general support of the basic setup of our reference models.

The results for the Northern samples are similar as measured by the likelihood ratio indices and the parameter estimates of most determinants. If EU trade observations were strongly biased by reporting errors, we would be able to detect general discrepancies in outsourcing estimation results for the reduced and full North sample. As can be seen from table 3, there is no direct evidence of such discrepancies.

The parameter estimates of the *VAPE* variable is negative and statistically different from zero at the one percent level, which indicates that MNEs with a relatively low productivity level are more likely to be engaged in FDI and outsourcing activities in the North and South. This could potentially reflect that all firms in our sample are multinational firms that have high productivity levels so that our sample does not provide sufficient variation in firm types to capture the expected pattern. This result may also be due to the lack of a strong relationship between the productivity level and size of the firm. (The maximum value of the simple correlation coefficient between the *VAPE* and *SALES* variable is 0.17.) While the firm size is fixed in the Grossman and Helpman (2004) model, it is directly linked to the productivity level in the Antràs and Helpman (2004, 2008) models. In the latter reference theories, the effect of a firm's productivity level on its profit-maximising behaviour hinges on the positive link to firm sales.

The *RCIPE* variable, which was included in the empirical model to clear the productivity estimate from real investment effects, has a positive impact on the firm choice to make foreign direct investments in the North and South. The firm's real capital investment per employee also has a positive effect on the firm decision to outsource production to the North but does not affect its outsourcing decision to the South. In cases when the *RCIPE* parameter coefficients are statistically different from zero, which is established at significance levels of up to five percent, their magnitudes are considerably larger in the FDI estimations compared to the outsourcing estimations. While this factor is irrelevant for the firm's foreign internalisation decision in our reference theories, the estimation results thereby indicate that it does affect firm behaviour in practice. This firm level evidence complements the industry level result that the physical capital intensity of production plays a key role in the foreign internalisation decision of firms that was put forward in Antras (2003) and Nunn and Trefler (2008).

The parameter coefficients of the *SALES* variable are positive and statistically different from zero at the one percent level, thereby providing support of that firm size matters for whether production takes place within the firm boundary as advocated by Antràs and Helpman (2004, 2008). The result that the *SALES* parameter coefficients are of larger sizes in the FDI estimations than in the outsourcing estimations is also in line with predictions of these models.

The estimation results reveal that the *SST* variable impacts positively on the firm decision to make foreign direct investments, which is verified at the one, ten or near ten percent level of significance depending on the underlying country sample. In contrast, there is a stark difference in the *SST* parameter estimate obtained for the different country samples. The *SST* parameter estimates are statistically different from zero, which can be established at the one percent level, for the reduced North and South samples. The specificity of the firm's technology impacts positively on the firm's outsourcing decision for the reduced North sample but cannot be shown to affect this decision for the full North sample. In combination, these results could display that firms at the technology frontier gain from outsourcing production to industrial core regions hosting the most efficient and specialised input suppliers. This potential explanation is supported by the fact that 25 percent of the frequency of outsourcing observations in the reduced North sample takes place in the US. The estimation results for the South sample provides strong support of the basic hypothesis that firms using more advanced production technologies prefer to purchase inputs from affiliated producers.

This result supplements the corresponding industry-level hypothesis provided by Antràs (2005).

All *MATH* parameter estimates are positive and statistically different from zero at the one percent level. The parameter coefficient of the *MATH* variable is of larger size in the outsourcing estimations than in the FDI estimations, thereby indicating that the market thickness of input suppliers impacts the most on the outsourcing decision of the firm.

The *IMPS* parameter estimates are also positive and statistically different from zero at the one percent level. These results simply reflect that firms purchase inputs from locations that have cost advantages in their production. The *IMPS* parameter coefficients in the outsourcing estimations exceed those in the FDI estimations, which suggests that international input cost differentials contribute more to explaining a firm's outside-boundary than within-boundary production.

The parameter estimates of the *EXPS* variable are positive and statistically different from zero at the one percent level in the FDI estimations, indicating that firms are prone to set up affiliate production to acquire foreign export platforms. In the outsourcing estimations, the *EXPS* parameter estimates are statistically different from zero only for the North. The firm's export share to a Northern foreign country has a negative effect on its decision to outsource production to that location, which is a statistically verified result at the one or five percent level.

That the *EXPS* parameter signs differ between the FDI and outsourcing estimations is consistent with explanations of the international specialisation of production from new trade theory. This theory predicts that countries with a large internal and diversified demand will become primary export markets. The estimation results suggest that these markets are located in the North as well as the South, which is a result working against the presumption that horisontal FDI predominantly takes place in the North. This interpretation supports one previously made by Nunn and Trefler (2008) in examining industry level evidence of U.S. firm behaviour.

Lastly, the estimation results provide no support of that the quality of legislation in the foreign country affects the firm's decision to make foreign direct investments or outsource production to the location. While this general result could indicate that an insufficient legislative quality in the foreign country does not impose any binding constraint on a firm's choice of organisational form and input source location, it may also be due to the presence of measurement errors in our indicator of legislative quality.

The research literature specialised on the economic effects of judicial institutions provide strong evidence of that the functioning of the legislative system is closely interlinked with a country's legal origin. La Porta et al. (1998) reveal that legal rights and investment protection vary systematically with the legal origin of countries. Moreover, Djankov et al. (2003) show that the procedural formalism that can be linked to a country's legal origin has a direct impact on the duration of dispute resolution, the enforceability of contracts and the consistency of the judicial system. To circumvent measurement error problems in investigating legislative quality as a determinant of our empirical model, the model is reestimated with the rule of law indicator exchanged for legal origin variables. We follow the comparative law literature in using english, socialist, french, german and scandinavian legal origin dummy variables.

The reestimation results, which are presented in table 4, are almost identical to those provided for the original model. Due to the strong similarity in estimation results, table 4 is placed in this paper's appendix. Legal origin dummies should be included in all estimations on based on Wald test results, which suggests that the foreign quality of the legislative system does indeed impact on the firm's outsourcing and FDI decisions if examined for a determinant that does not incorporate measurement errors. While a detailed comparative law investigation is outside the scope of this paper, our evidence provides tentative support of the property rights approach to determining the firm boundary.

V. TESTING BEHAVIOURAL SELF-SELECTION PATTERNS

This section presents the self-selection pattern of Swedish MNEs with respect to the impact of each determinant. While our reference theories predominantly are focused on productivity effects on the foreign internalisation decision of firms, they also predict that this decision depends on other determinants that affect the profitability of firm behaviour. The foreign internalisation choice can therefore be categorised by each determinant, which can be done by performing ranking tests across behavioural categories. Twofold tests are performed to assess the ranking of a category pair on the basis of the separate estimations of each choice combination of organisational form and input source location.

Table 5 presents the ranking test results of category pairs, with a larger positive (or a smaller negative) parameter effect receiving a higher rank. The results in the table are based on the original model estimation. It should be noted that equivalent ranking results are obtained for the same determinants in the modified model. No conclusive ranking results can be presented for the legal origin dummies due to country sample differences. As can be seen

from the table, a strict ranking exists between each of the six categories for the *VAPE*, *SALES* and *IMPS* determinants. For the *RCIPE*, *EXPS* and *SST* variables, the parameter's observed effect on firm behaviour can be ordered statistically for some categories. Lastly, no self-selection pattern of firms can be statistically validated for the *QL* variable due to its imprecise parameter estimates.

The reported evidence of the ranking tests adds support to the general conclusion that the firm's two-dimensional organisational and input location choice is affected by all determinants except the quality of legislation variable. The ordering of categories reveals that there is a (statistically supported) direct link between the firm's choice of organisational form and the parameter impact of the *RCIPE, SALES, MATH, IMPS* and *EXPS* variables. The self-selection pattern of firms reveal that the physical capital intensity of the firm's production, the firm size and the firm's export share to the foreign country favours the firm choice of within-boundary production while the foreign market thickness of input suppliers and the firm's import share from the foreign country favours the firm choice of outside-boundary production.

For the *VAPE* and *SST* determinants, the parameter effect on the firm's organisational choice is more complex with the decision to outsource production receiving a lower or higher rank than the FDI decision depending on where the inputs are sourced from. To provide an overview of the complete ranking of behavioural categories, the self-selection pattern of firms is presented in table 6. A ranking test result that indicates a strict ordering of categories is reported as a strict inequality in the table.

The self-selection pattern of firms with respect to the *VAPE* determinant shows that the least and most productive firms outsource their production, albeit to different locations. The least productive firms outsource production to the North only if foreign EU countries are included in the sample. This result is likely to reflect that the least productive Swedish MNEs choose to outsource production to suppliers in the European Union because organisational costs of establishing a successful relationship with independent input providers are relatively low in the internal EU market. The result is also consistent with the Antràs and Helpman (2004, 2008) prediction that the least productive firms outsource production to the North.

If excluding foreign EU members from the sample, outsourcing to the North is instead performed by high-productivity firms. This result contrasts to the self-selection pattern of firms identified in all underlying reference theories. The diverse ranking of the North samples clearly suggests that the localisation dimension of the foreign internalisation choice of firms

need to address more country characteristics than those defined by the North/South and contracting environment perspectives.

The most productive firms outsource production to the South. This result is consistent with the Grossman and Helpman (2004) model and provides support of the hypothesis that high-productivity firms use rent sharing to extract more efforts from their input provider(s). Lastly, the higher ranking of within-boundary production that takes place in the South compared to the North is consistent with Antràs and Helpman (2004, 2008). To sum up, the self-selection pattern of firms identified with respect to firm productivity levels provide mixed support of our reference theories.

The self-selection pattern of firms with respect to the firm's physical capital intensity of production shows that, while firms with high capital intensities choose inhouse production, those that are most capital intensive place their affiliate production in the North. This pattern could reflect the fact that a firm with a more capital intensive production is less sensitive to high labour costs. This pattern is replicated by the firms that, due to low physical capital intensities in production, outsource their input production (though this is statistically confirmed only for the full North and South samples).

The ranking of behavioural categories with respect to the firm size is identical to that identified for the firm's physical capital intensity of production. This resemblance is likely to reflect that Swedish MNEs traditionally (after WWII) have been specialised in capital intensive production and that successful firms (with large global market shares) therefore often have displayed high capital intensities compared to other firms in the industry. In contrast to theory, the ranking pattern of firms with respect to their productivity levels and sizes is inconsistent.

The self-selection pattern of firms with respect to the *SST* determinant confirms the previously described result that firms with the most advanced technologies outsource production to Northern locations outside the European Union. Firms that have advanced technologies inside the technological frontier instead choose to internalise their foreign input production. Another ranking result that can be verified statistically for the *SST* parameter is that firms with the least advanced technologies outsource production to the South. The latter result is consistent with the basic hypothesis that outsourcing to the South occurs at the last stage of the product cycle, when the production technology has become standardised. This is a main explanation of the foreign internalisation decision in Antràs's (2005) trade model based on firm homogeneity within industries.

The ranking of behavioural categories with respect to the *MATH* variable indicates that the market thickness of input suppliers impacts more on the firm decision to outsource production to the North than to the South. This result supports the argument that a well-established market foundation increases the profitability of contracting independent suppliers in a location. As previously described, the *MATH* parameter also affects the firm choice to set up affiliate production sites in the foreign location (though the parameter impacts are of smaller sizes). Furthermore, the market thickness of input suppliers impacts the least on the firm decision to make foreign direct investments in the North as measured by the full sample. This result suggests that firms choosing to set up foreign production sites within the firm boundary in the European Union are the least sensitive to the development of input markets.

The ranking results for the *IMPS* variable show that the firm's import share from the foreign country impacts more on the firm choice to source production from the South than the North. This result provides further support of the conclusion that North-South input cost differentials has a decisive impact on the firm's choice of input source location. The self-selection pattern of firms with respect to the *EXPS* determinant confirms the previously described interpretation that export platform markets are located in the North as well as in the South.

VI. CONCLUDING DISCUSSION

The main contribution of this paper was the firm level investigation of foreign internalisation decisions. The empirical examination was performed using recent, detailed firm level data on Swedish MNEs. Overall, our empirical evidence supports the unified approach of the reference theories where a firm's two-dimensional choice of organisational form (integration/outsourcing) and foreign input source location (North/South) is jointly determined. Our empirical investigation showed that a theoretically founded set of determinants explained the foreign internalisation choice of the firm, though only weak evidence was provided for the basic hypothesis that this decision is affected by the quality of legislation in the input source location.

The empirical results provide strong evidence of that the firm's foreign internalisation decision is affected by the productivity level and the size of the firm. The direct link prevailing between these factors in theory is however weak, suggesting that the previous empirical industry-level evidence on the foreign internalisation decision of the firm could be biased. Trade theoretic underpinnings of the reference models were accounted for by use of firm-specific bilateral trade composition variables in the estimations. These determinants were

also supported in our empirical investigation, not only in affecting the firm's location decision but also in determining its choice of organisation.

Our reference models, Antràs and Helpman (2004, 2008) and Grossman and Helpman (2004), show that the firm's productivity level plays a key role in explaining firm behaviour. The self-selection pattern of firms identified with respect to the firm's productivity level provides mixed support of these theories. Our empirical investigation shows that, amongst firms that choose inhouse production, the most productive ones choose to set up foreign affiliate production in the South. This hypothesis is coherent with a prediction of the Antràs and Helpman (2004, 2008) models, which was based on the argument that only the most productive firms could obtain large enough sales to gain despite the additional rigidities incurred in the producer relationship in the South. Since the strong link between the productivity level and sales of the firm doesn't prevail in our data, the result does however reflect some other productivity effect than those advocated by Antràs and Helpman.

Our evidence on the ranking of behavioural categories with respect to firm productivity is also consistent with the Grossman and Helpman (2004) prediction that the most productive firms outsource their input production to the South. This outcome was based on the hypothesis that the most productive firms gain from extracting strong efforts from the input provider through rent sharing.

The empirical investigation also indicated that the foreign internalisation decision was affected by three control variables: The firm's physical capital intensity, the technological specificity of the firm's production and the foreign market thickness of input suppliers. While these factors have no formal base in our reference theories, previous researchers provide evidence of their effect on the firm's foreign internalisation choice (at the industry level or in determing the FDI or outsourcing decision of the firm).

Our examination reveals that firms with production characterised by high physical capital intensities choose within-boundary production while firms with low physical capital intensities of production choose outside-boundary production. Furthermore, the firms that are more capital intensive within each interval range source their inputs from Northern locations. These results reveal that the firm's physical capital intensity of production does matter for its foreign internalisation choice. This empirical evidence is likely to be influenced by the Swedish perspective of this study, since MNEs in Sweden traditionally has tended to display high physical capital intensities of production. Nevertheless, it is well worth investigating whether the result persists for other country perspectives as well.

The empirical investigation provides some support of that the firm's foreign internalisation decision can be explained by product cycle theory. Antràs (2005) has presented formal evidence of this theory at the industry level, while our results indicate that the technological specificity of the firm's production affects firm behaviour per se. Our empirical results show that firms with the most advanced technologies set up affiliate production units in (some) Northern locations while firms with the least advanced (i.e. standardised) production techniques outsource their input production to the South.

We receive weak support of that the foreign quality of legislation serves as a determinant of the foreign internalisation decision by taking account of the legal origin of the country. In the comparative law research field, this aspect of the judicial system has been shown to be highly correlated with the quality of the legislative system. In combination with the fact that direct measures on this quality does not appear to carry any explanatory power in our estimations, the empirical support of that the foreign country's legal origin should be incorporated into the empirical model therefore suggests that direct measures of the contract enforcement environment needs to be assessed by variables unaffected by measurement error bias.

APPENDIX

RULE OF LAW INDICATOR FACTOR DESCRIPTION (Reported by Source: Factor)

Business environment risk intelligence unit: Direct financial fraud, money laundering and organised crime.
Cingranelli Richards human rights database and political terror scale: Independency of judiciary.
Economist intelligence unit: Violent crime, organised crime, fairness of judicial process, enforceability of contracts, speediness of judicial process and confiscation/expropriation.
Gallup world poll: Confidence in the police force, confidence in judicial system and indicator of whether respondent has been a crime victim.
Global insight global risk service: Losses and costs of crime, kidnapping of foreigners, enforceability of government contracts and enforceability of private contracts.
Global insight business conditions and risk indicators: Judicial independence and crime.
Heritage foundation index of economic freedom: Property rights.
Merchant international group gray area dynamics: Organised crime and legal safeguards.
Political risk services international country risk guide: Law and order.
US State department: Trafficking in people.
World economic forum global competitiveness survey: Imposed costs of common crime on business, imposed cost of organised crime on business, quality of police, judiciary independence from political influences of members of government, citizens or firms, inefficiency of legal framework implemented to challenge the legality of government actions, weak property protection, weak protection of financial assets, tax evasion.

TABLE 4: REESTIMATION RESULTS[α]

INDVAR/DEPVAR	*FDI*	*FDI*	*FDI*	*OUT*	*OUT*	*OUT*
VAPE	-0.069	-0.053	-0.047	-0.070	-0.043	-0.025
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RCIPE	0.135	0.116	0.091	0.008	0.007	0.002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.015)	(0.431)
SALES	0.157	0.144	0.117	0.089	0.086	0.038
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SST	0.032	0.054	0.118	0.011	0.127	-0.082
	(0.126)	(0.074)	(0.000)	(0.458)	(0.000)	(0.000)
MATH	0.003	0.007	0.004	0.040	0.036	0.026
	(0.004)	(0.000)	(0.00)	(0.000)	(0.000)	(0.000)
IMPS	0.093	0.089	0.350	0.851	0.843	0.524
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
EXPS	0.345	0.232	0.250	-0.099	-0.035	-0.023
	(0.000)	(0.000)	(0.000)	(0.000)	(0.024)	(0.266)
LRI	0.437	0.427	0.599	0.321	0.347	0.400
LD	Y	Y	Y	Y	Y	Y
TD	Y	Y	Y	Y	Y	Y
ID	Y	Y	Y	Y	Y	Y
CD	Y	Y	Y	Y	Y	Y
SAMPLE	$NORTH_F$	$NORTH_R$	SOUTH	$NORTH_F$	$NORTH_R$	SOUTH
N	42553	17952	16943	42649	17975	16730

[α] The reported parameter estimates are marginal effects. P-values are provided within parentheses.

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NOTES

[1] Tybout (2003) and Helpman (2006) provide surveys of this research area.
[2] See, amongst others, Feenstra and Hansson (1996, 1999).
[3] See Spencer (2005) for a thorough review of the alternative approaches used to formalise a firm's foreign internalisation decision.
[4] It is never profitable for the firm to outsource input production to the North in the Grossman and Helpman (2004) model.
[5] The transaction cost approach to explaining the firm boundary originates from Coase's (1937) seminal contribution.
[6] See Motta and Norman (1996), Neary (2002), Yeaple (2003) and Ekholm et al. (2007) for alternative formalisations of export-platform FDI.
[7] The SNI industry categories correspond to those of the EU recommended NACE Rev 1.1 classification.
[8] The inflation adjustments were based on annual consumer price index (CPI) values provided by Statistics Sweden.
[9] The governance indicator webpage is found at http://info.worldbank.org/governance/wgi/index.asp.

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TABLES INCLUDED IN TEXT

TABLE 1: SUMMARY STATISTICS

VARIABLE	MEAN	MIN	MAX	STD	SAMPLE
FDI	0.37	0.00	1.00	0.48	$NORTH_F$
FDI	0.35	0.00	1.00	0.48	$NORTH_R$
FDI	0.30	0.00	1.00	0.46	SOUTH
OUT	0.44	0.00	1.00	0.50	$NORTH_F$
OUT	0.42	0.00	1.00	0.49	$NORTH_R$
OUT	0.22	0.00	1.00	0.41	SOUTH
VAPE	6.41	1.46	12.06	0.51	$NORTH_F$
VAPE	6.41	1.46	11.59	0.54	$NORTH_R$
VAPE	6.42	1.51	12.06	0.53	SOUTH
RCIPE	6.58	0.37	15.21	1.43	$NORTH_F$
RCIPE	6.53	0.37	15.21	1.46	$NORTH_R$
RCIPE	6.60	0.37	14.50	1.44	SOUTH
SALES	12.30	5.56	19.20	1.99	$NORTH_F$
SALES	12.19	5.56	19.20	2.02	$NORTH_R$
SALES	12.57	5.56	19.20	2.32	SOUTH
SST	0.39	0.00	1.00	0.20	$NORTH_F$
SST	0.39	0.00	1.00	0.21	$NORTH_R$
SST	0.40	0.00	1.00	0.20	SOUTH
MATH	14.63	0.00	22.50	6.32	$NORTH_F$
MATH	13.50	0.00	21.91	6.35	$NORTH_R$
MATH	7.84	0.00	21.19	7.51	SOUTH
IMPS	0.07	0.00	1.00	0.17	$NORTH_F$
IMPS	0.07	0.00	1.00	0.19	$NORTH_R$
IMPS	0.04	0.00	1.00	0.14	SOUTH
EXPS	0.10	0.00	1.00	0.21	$NORTH_F$
EXPS	0.14	0.00	1.00	0.27	$NORTH_R$
EXPS	0.03	0.00	1.00	0.14	SOUTH
QL	0.75	0.41	0.84	0.08	$NORTH_F$
QL	0.74	0.41	0.84	0.10	$NORTH_R$
QL	0.55	0.15	0.81	0.14	SOUTH

TABLE 2: CORRELATION MATRICES ($NORTH_F$,$NORTH_R$,SOUTH)

	VAPE	*RCIPE*	*SALES*	*SST*
RCIPE	0.32,0.32,0.30			
SALES	0.17,0.17,0.16	0.53,0.50,0.53		
SST	0.00,0.01,0.02	0.02,0.04,0.08	0.06,0.08,0.16	
MATH	0.06,0.04,0.02	0.02,0.01,-0.00	-0.03,-0.04,-0.02	0.01,0.01,-0.02
IMPS	0.02,0.02,-0.03	0.05,0.02,-0.03	0.01,-0.03,-0.07	0.03,0.06,-0.08
EXPS	-0.02,-0,02, 0.01	-0.07,-0.08,-0.05	-0.13,-0.16,-0.13	-0.09,-0.11,-0.04
QL	-0.01,-0.01,-0.05	-0.02,-0.02,-0.09	-0.04,-0.07,-0.19	-0.03,-0.04,-0.07
	MATH	*IMPS*	*EXPS*	
IMPS	0.16,0.15,0.17			
EXPS	0.18,0.21,0.08	0.18,0.22,0.22		
QL	0.16,0.15,0.01	0.06,0.06,0.02	0.17,0.20,-0.03	

TABLE 3: ESTIMATION RESULTS[α]

INDVAR/DEPVAR	*FDI*	*FDI*	*FDI*	*OUT*	*OUT*	*OUT*
VAPE	-0.069 (0.000)	-0.053 (0.000)	-0.047 (0.000)	-0.070 (0.000)	-0.043 (0.000)	-0.026 (0.000)
RCIPE	0.135 (0.000)	0.116 (0.000)	0.092 (0.000)	0.008 (0.000)	0.007 (0.015)	0.002 (0.407)
SALES	0.157 (0.000)	0.144 (0.000)	0.117 (0.000)	0.089 (0.000)	0.086 (0.000)	0.037 (0.000)
SST	0.033 (0.125)	0.054 (0.074)	0.117 (0.000)	0.011 (0.458)	0.127 (0.000)	-0.082 (0.000)
MATH	0.003 (0.004)	0.007 (0.000)	0.004 (0.000)	0.040 (0.000)	0.036 (0.000)	0.026 (0.000)
IMPS	0.092 (0.000)	0.089 (0.001)	0.351 (0.000)	0.851 (0.000)	0.844 (0.000)	0.522 (0.000)
EXPS	0.345 (0.000)	0.231 (0.000)	0.249 (0.000)	-0.099 (0.000)	-0.035 (0.024)	-0.024 (0.260)
QL	0.179 (0.620)	0.023 (0.967)	-0.255 (0.210)	0.015 (0.953)	-0.193 (0.635)	-0.115 (0.342)
LRI	0.437	0.427	0.599	0.321	0.347	0.401
TD	Y	Y	Y	Y	Y	Y
ID	Y	Y	Y	Y	Y	Y
CD	Y	Y	Y	Y	Y	Y
SAMPLE	$NORTH_F$	$NORTH_R$	SOUTH	$NORTH_F$	$NORTH_R$	SOUTH
N	42553	17952	16943	42649	17975	16717

[α] The reported parameter estimates are marginal effects. P-values are provided within parentheses.

TABLE 5: RANKING TEST RESULTS[α]

RANK/VAR	*VAPE*	*RCIPE*	*SALES*	*SST*
1, 2	$(OUT_S, OUT_{NR})^{***}$	$(FDI_{NF}, FDI_{NR})^{***}$	$(FDI_{NF}, FDI_{NR})^{***}$	$(OUT_{NR}, FDI_S)^{***}$
2, 3	$(OUT_{NR}, FDI_S)^{***}$	$(FDI_{NR}, FDI_S)^{***}$	$(FDI_{NR}, FDI_S)^{***}$	(FDI_S, FDI_{NR})
3, 4	$(FDI_S, FDI_{NR})^{***}$	$(FDI_S, OUT_{NF})^{***}$	$(FDI_S, OUT_{NF})^{***}$	(FDI_{NR}, FDI_{NF})
4, 5	$(FDI_{NR}, FDI_{NF})^{***}$	$(OUT_{NF},OUT_{NR})^{*\beta}$	$(OUT_{NF},OUT_{NR})^{***}$	(FDI_{NF}, OUT_{NF})
5, 6	$(FDI_{NF}, OUT_{NF})^{***}$	(OUT_{NR}, OUT_S)	$(OUT_{NR}, OUT_S)^{***}$	$(OUT_{NF}, OUT_S)^{**}$
RANK/VAR	*MATH*	*IMPS*	*EXPS*	*QL*
1, 2	$(OUT_{NF},OUT_{NR})^{***}$	$(OUT_S,OUT_{NF})^{***}$	$(FDI_{NF},FDI_S)^{***}$	(OUT_{NF},OUT_{NR})
2, 3	$(OUT_{NR}, OUT_S)^{***}$	$(OUT_{NF},OUT_{NR})^{***}$	$(FDI_S,FDI_{NR})^{***}$	(OUT_{NR},OUT_S)
3, 4	$(OUT_S, FDI_{NR})^{*}$	$(OUT_{NR},FDI_S)^{***}$	$(FDI_{NR},OUT_S)^{***}$	(OUT_S,FDI_{NR})
4, 5	$(FDI_{NR}, FDI_S)^{**}$	$(FDI_S,FDI_{NF})^{**}$	(OUT_S,OUT_{NR})	(FDI_{NR},FDI_S)
5, 6	$(FDI_S, FDI_{NF})^{*\beta}$	$(FDI_{NF},FDI_{NR})^{**}$	(OUT_{NR},OUT_{NF})	(FDI_S,FDI_{NF})

[α] Asterisks depict that a strict ranking of categories is supported by twofold ranking tests (at the one, five or ten percent significance level as denoted by *,** and ***).

[β] The strict ranking of categories is supported near the 10 percent level (with a significance level below 11 percent).

TABLE 6: RANKING OVERVIEW[α]

VARIABLE	**SELF-SELECTION PATTERN**
VAPE	$OUT_{NF} < FDI_{NF} < FDI_{NR} < FDI_S < OUT_{NR} < OUT_S$
RCIPE	$OUT_S \leq OUT_{NR} < OUT_{NF} < FDI_S < FDI_{NR} < FDI_{NF}$
SALES	$OUT_S < OUT_{NR} < OUT_{NF} < FDI_S < FDI_{NR} < FDI_{NF}$
SST	$OUT_S < OUT_{NF} \leq FDI_{NF} \leq FDI_{NR} \leq FDI_S < OUT_{NR}$
MATH	$FDI_{NF} < FDI_S < FDI_{NR} < OUT_S < OUT_{NR} < OUT_{NF}$
IMPS	$FDI_{NR} < FDI_{NF} < FDI_S < OUT_{NR} < OUT_{NF} < OUT_S$
EXPS	$OUT_{NF} \leq OUT_{NR} \leq OUT_S < FDI_{NR} < FDI_S < FDI_{NF}$
QL	$FDI_{NF} \leq FDI_S \leq FDI_{NR} \leq OUT_S \leq OUT_{NR} \leq OUT_{NF}$

[α] Inequalities are based on twofold ranking tests.