# Productivity, Relationship-Specific Inputs and the Sourcing Modes of Multinationals

## *Online Appendix with Supplementary Materials.* ⋆

Fabrice Defever [a] and Farid Toubal [b]

*Journal of Economic Behavior & Organization, forthcoming*

---

⋆ Not for publication.

[a] *University of Nottingham, School of Economics and Centre for Economic Performance at the London School of Economic. Sir Clive Granger Building, University Park, NG7 2RD, Nottingham. United Kingdom. Email: fabrice.defever@nottingham.ac.uk.*

[b] *University of Angers, Paris School of Economics and CEPII. Centre d'Économie de la Sorbonne, 106-112 Boulevard de l'Hôpital, 75647 Paris. E-mail: toubal@univ-paris1.fr.*

Online Appendix with Supplementary Materials

## A TFP Measurement

We use the Olley and Pakes (1996) (OP) semiparametric method to estimate firm-level TFP. Estimations have been made for each one of the 52 sectors (3 digit). This method allows a robust estimation of the production function. It takes into account the endogeneity of some inputs, as well as the unobserved permanent differences among firms. The main assumption that the OP technique relies on, is the existence of a monotonic relationship between investment and firm-level unobserved heterogeneity.

We consider the following Cobb-Douglas production function

$$Q_{it} = \lambda_0 + \lambda_K K_{it} + \lambda_L L_{it} + \lambda_M M_{it} + \theta_{it} + \epsilon_{it}$$

and denote the logarithm of output, capital, labor and intermediate inputs with $Q_{it}$, $K_{it}$, $L_{it}$ $M_{it}$, respectively. Subscripts $i$ and $t$ stand for firm and time, $\theta_{it}$ denotes productivity, and $\epsilon_{it}$ stands for measurement error in output. It is assumed that $\theta_{it}$ follows an exogenous first order Markov process:

$$\theta_{it+1} = E[\theta_{it+1}|\theta_t] + \upsilon_{it+1}$$

where $\upsilon_{it}$ is uncorrelated with the productivity shock. The endogeneity problem stems from the fact that $K_{it}$ and $L_{it}$ are correlated with the $\theta_{it}$. This makes $\lambda_{OLS}$ biased and inconsistent. Given that investment is strictly monotonic, it can be inverted as:

$$\theta_{it} = h(I_{it}, K_{it})$$

and substituting this function in the production function leads to

$$Q_{it} = \lambda_L L_{it} + \lambda_M M_{it} + \Phi(I_{it}, K_{it}) + \epsilon_{it}$$

where $\Phi(I_{it}, K_{it}) = \lambda_0 + \lambda_K K_{it} + h(I_{it}, K_{it})$. Since the functional form of $\Phi(\cdot)$ is not known, we cannot estimate the coefficients of the capital and labor variable directly. Instead, we use a linear model that includes a series estimator using a full interaction term polynomial in capital and investment to approximate $\Phi(\cdot)$. From this first stage, the consistent estimates of the coefficients on labor and material inputs as well as the estimate of the polynomial in $I_{it}$ and $K_{it}$ are obtained. The estimated coefficients are shown in Table A.

| | OLS | | | OP | | |
|---|---|---|---|---|---|---|
| | $\beta_M$ | $\beta_L$ | $\beta_K$ | $\beta_M$ | $\beta_L$ | $\beta_K$ |
| C11 | 0.54 | 0.31 | 0.05 | 0.54 | 0.25 | 0.06 |
| C12 | 0.48 | 0.42 | 0.06 | 0.50 | 0.34 | 0.06 |
| C20 | 0.62 | 0.33 | 0.03 | 0.69 | 0.25 | 0.01 |
| C31 | 0.77 | 0.15 | 0.06 | 0.78 | 0.12 | 0.01 |
| C32 | 0.76 | 0.23 | 0.01 | 0.77 | 0.20 | 0.02 |
| C41 | 0.63 | 0.33 | 0.05 | 0.67 | 0.27 | 0.05 |
| C42 | 0.68 | 0.24 | 0.04 | 0.66 | 0.20 | 0.08 |
| C43 | 0.61 | 0.29 | 0.08 | 0.61 | 0.23 | 0.10 |
| C44 | 0.74 | 0.22 | 0.02 | 0.77 | 0.19 | 0.03 |
| C45 | 0.61 | 0.32 | 0.05 | 0.62 | 0.28 | 0.10 |
| C46 | 0.54 | 0.40 | 0.06 | 0.59 | 0.34 | 0.03 |
| D01 | 0.70 | 0.31 | 0.01 | 0.71 | 0.27 | -0.04 |
| D02 | 0.71 | 0.25 | 0.03 | 0.72 | 0.16 | 0.08 |
| E11 | 0.56 | 0.45 | 0.00 | 0.63 | 0.37 | 0.02 |
| E12 | 0.70 | 0.26 | 0.03 | 0.70 | 0.26 | 0.03 |
| E13 | 0.48 | 0.60 | 0.00 | 0.56 | 0.32 | 0.03 |
| E14 | 0.59 | 0.41 | 0.00 | 0.63 | 0.43 | -0.04 |
| E21 | 0.58 | 0.37 | 0.07 | 0.65 | 0.27 | 0.06 |
| E22 | 0.41 | 0.56 | 0.05 | 0.50 | 0.46 | 0.02 |
| E23 | 0.59 | 0.36 | 0.06 | 0.63 | 0.32 | 0.05 |
| E24 | 0.60 | 0.38 | 0.03 | 0.66 | 0.32 | 0.03 |
| E25 | 0.52 | 0.46 | 0.06 | 0.62 | 0.31 | 0.05 |
| E26 | 0.54 | 0.42 | 0.03 | 0.59 | 0.34 | 0.08 |
| E27 | 0.52 | 0.44 | 0.06 | 0.58 | 0.31 | 0.07 |
| E28 | 0.61 | 0.34 | 0.07 | 0.63 | 0.32 | 0.00 |
| E31 | 0.62 | 0.41 | 0.00 | 0.63 | 0.38 | 0.04 |
| E32 | 0.56 | 0.37 | 0.09 | 0.58 | 0.34 | 0.08 |
| E33 | 0.54 | 0.44 | 0.06 | 0.59 | 0.35 | 0.06 |
| E34 | 0.51 | 0.38 | 0.10 | 0.54 | 0.27 | 0.13 |
| E35 | 0.55 | 0.42 | 0.06 | 0.59 | 0.39 | 0.05 |
| F13 | 0.50 | 0.42 | 0.11 | 0.53 | 0.34 | 0.09 |
| F14 | 0.62 | 0.32 | 0.07 | 0.66 | 0.24 | 0.05 |
| F21 | 0.66 | 0.23 | 0.02 | 0.68 | 0.17 | 0.05 |
| F22 | 0.54 | 0.41 | 0.03 | 0.56 | 0.31 | 0.05 |
| F23 | 0.62 | 0.26 | 0.04 | 0.61 | 0.20 | 0.06 |
| F31 | 0.64 | 0.28 | 0.07 | 0.63 | 0.26 | 0.07 |
| F32 | 0.70 | 0.27 | 0.05 | 0.71 | 0.19 | 0.10 |
| F33 | 0.56 | 0.42 | 0.05 | 0.62 | 0.31 | 0.07 |
| F41 | 0.68 | 0.30 | 0.02 | 0.66 | 0.20 | 0.13 |
| F42 | 0.77 | 0.16 | 0.06 | 0.68 | 0.06 | 0.14 |
| F43 | 0.75 | 0.23 | 0.03 | 0.75 | 0.16 | 0.10 |
| F44 | 0.74 | 0.18 | 0.03 | 0.73 | 0.07 | 0.07 |
| F45 | 0.55 | 0.45 | 0.03 | 0.61 | 0.37 | 0.04 |
| F46 | 0.59 | 0.40 | 0.04 | 0.63 | 0.29 | 0.01 |
| F51 | 0.70 | 0.19 | 0.09 | 0.68 | 0.15 | 0.02 |
| F52 | 0.81 | 0.08 | 0.08 | 0.78 | 0.10 | 0.08 |
| F53 | 0.52 | 0.41 | 0.07 | 0.62 | 0.30 | 0.06 |
| F54 | 0.44 | 0.49 | 0.07 | 0.53 | 0.35 | 0.06 |
| F55 | 0.52 | 0.39 | 0.08 | 0.55 | 0.30 | 0.03 |
| F56 | 0.61 | 0.27 | 0.07 | 0.67 | 0.17 | 0.03 |
| F61 | 0.59 | 0.36 | 0.04 | 0.61 | 0.30 | 0.06 |
| F62 | 0.55 | 0.37 | 0.08 | 0.57 | 0.30 | 0.09 |

## B Firm weight and the probability to answer the survey

The SESSI firm survey includes French firms trading with more than 1 million Euro worth of goods and that are owned by manufacturing groups that control at least 50% of the equity capital of their foreign affiliates. These limitations sharply reduce the number of participants. However, the coverage remains significant.

An important limitation in the survey is that only 55% of the firms answered the questionnaire. To take into account the resulting sample bias, the SESSI includes in its survey a weighting coefficient that is firm-specific and corresponds to the inverse probability that a firm answers the survey. The model used to build this coefficient is a simple logistic model that relates the probability to answer the survey and several firm characteristics: firm's trade volumes, its 2-digit sector classification, and the nationality of its group. The results of this exercise are as follow: large firms, trading important volume and firms part of a French group were significantly more likely to answer the questionnaire. [1]

[1] For 330 Firms for which the SESSI did not affect any weighting coefficient, we affect the average weighting coefficient of 1.6. As a robustness check, we also run regression with applying a coefficient of 1 (the minimum possible value) and of 3.6 (the maximum value observed) to these firms. We do not present these results.

## C Results from Linear Probability Model

Table C.1 reports the results of regressions of an estimation that uses the linear probability model on the full sample. The results in column (S1) document a positive correlation between the firm productivity level, its level relationship specific inputs and the probability to outsource. In column (S2), we include the interaction term. As predicted by the theory, the interaction coefficient is positive and significant. In particular, the probability to import from independent suppliers is positively related to firms that are the most productive and have a large share of relationship specific inputs. Column (S3) confirms these first findings by including information on firm-level characteristics. Notice that the introduction of the firm-level characteristics reduces slightly the significance of the interaction coefficient.

Table C.1
Preliminary Results. Dependent variable: Y= share of outsourcing (Linear Probability Model)

| | Label | (S1) | (S2) | (S3) |
|---|---|---|---|---|
| Productivity | $\theta_i$ | $0.005^a$ | $0.005^a$ | $0.006^a$ |
| | | (0.000) | (0.000) | (0.000) |
| RSI intensity | $\omega_i$ | $0.071^a$ | $0.068^a$ | $0.070^a$ |
| | | (0.004) | (0.005) | (0.005) |
| Interaction term | $\theta \times \omega_i$ | | $0.001^a$ | $0.001^b$ |
| | | | (0.000) | (0.000) |
| Skill intensity | $(s/l)_i$ | | | $-0.023^a$ |
| | | | | (0.002) |
| Capital-labor ratio | $(k/l)_i$ | | | -0.002 |
| | | | | (0.002) |
| Observations | | 68590 | 68590 | 68590 |
| Adjusted $R^2$ | | 0.152 | 0.152 | 0.155 |
| Number of firms | | 2394 | 2394 | 2394 |

All regressions contain sector, product and country fixed effects. Robust standard error into brackets. $^a$, $^b$ , $^c$ significantly different from 0 at 1%, 5% and 10% level, respectively.

## D The two-stage equation

In this section, we use a more restrictive definition that takes into account the product dimension. We construct a dummy variable, $g_{jl}$ which takes the value of 1 if the firm has a related party in a foreign country $l$ that can provide a 3-digit input $j$. The analysis is conducted as in the main text. The selection equation is estimated using a probit model on the $g_{jl}$ dummy variable and specified using the number of the firm's related parties located in France owned by the firm's UBO and a dummy variable that identifies firms that are owned by a foreign group. In the second stage equation is augmented by the inverse Mill's ratio.

## References

Olley, S. and A. Pakes (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica 64*(6), 1263–1298.

Table D.1. Sample selection specifications

| | | Full sample | | | | | Intermediate inputs sample | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Two stages equation | | | | | Two stages equation | |
| | | | | | $1^{st}$ stage | $2^{nd}$ stage | | | | $1^{st}$ stage | $2^{nd}$ stage |
| | | (S1) | (S2) | (S3) | (S4) | (S5) | (S6) | (S7) | (S8) | (S9) | (S10) |
| Productivity | $\theta_i$ | 0.012$^a$ | 0.012$^a$ | 0.013$^a$ | -0.003 | 0.012$^a$ | 0.015$^a$ | 0.014$^a$ | 0.014$^a$ | -0.002 | 0.014$^a$ |
| | | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.004) | (0.004) | (0.004) | (0.003) | (0.003) |
| RSI intensity | $\omega_i$ | 0.127$^c$ | 0.183$^a$ | 0.191$^a$ | -0.075$^a$ | 0.206$^a$ | 0.170$^b$ | 0.213$^a$ | 0.221$^a$ | -0.091$^a$ | 0.247$^a$ |
| | | (0.067) | (0.053) | (0.054) | (0.023) | (0.051) | (0.084) | (0.064) | (0.065) | (0.030) | (0.061) |
| Interaction term | $\theta \times \omega_i$ | | 0.013 | 0.013$^c$ | -0.002 | 0.014$^a$ | | 0.012 | 0.013$^c$ | -0.003 | 0.014$^a$ |
| | | | (0.004) | (0.004) | (0.002) | (0.004) | | (0.004) | (0.005) | (0.002) | (0.005) |
| Skill intensity | $(s/l)_i$ | | | -0.023$^b$ | 0.019$^b$ | -0.028$^b$ | | | -0.021 | 0.019$^c$ | -0.026$^c$ |
| | | | | (0.011) | (0.009) | (0.011) | | | (0.014) | (0.011) | (0.014) |
| Capital-labor ratio | $(k/l)_i$ | | | -0.014 | -0.016 | -0.011 | | | 0.005 | -0.022 | 0.007 |
| | | | | (0.019) | (0.013) | (0.019) | | | (0.024) | (0.017) | (0.022) |
| UBO - Number of related French affiliates | $a_u$ | | | | 0.118$^a$ | | | | | 0.110$^a$ | |
| | | | | | (0.013) | | | | | (0.015) | |
| UBO - Foreign group | $Foreign_u$ | | | | 0.285$^a$ | | | | | 0.281$^a$ | |
| | | | | | (0.025) | | | | | (0.027) | |
| Mills ratio | $Mills$ | | | | | -0.430$^b$ | | | | | -0.498$^c$ |
| | | | | | | (0.208) | | | | | (0.257) |
| Observations | | 35171 | 35171 | 35171 | 68574 | 35155 | 22793 | 22793 | 22793 | 49000 | 22786 |
| Log likelihood | | -29349 | -29283 | -29226 | -40007 | -29176 | -18902 | -18875 | -18850 | -28219 | -18812 |
| Number of firms | | 1943 | 1943 | 1943 | 2391 | 1940 | 1633 | 1633 | 1633 | 2182 | 1632 |

All regressions contain sector, product and country fixed effects Robust standard error clustered at the firm level into brackets. $^a$, $^b$ , $^c$ significantly different from 0 at 1%, 5% and 10% level, respectively.