Journal of International Economics 93 (2014) 123–139

Contents lists available at ScienceDirect

Journal of International Economics

journal homepage: www.elsevier.com/locate/jie

Global sourcing of complex production processes ☆

Christian Schwarz [a], Jens Suedekum [a,b,*]

[a] Mercator School of Management, University of Duisburg-Essen, Germany
[b] Düsseldorf Institute for Competition Economics (DICE), Heinrich-Heine-University Düsseldorf, CESifo and IZA, Universitätsstrasse 1, 40225 Düsseldorf, Germany

ARTICLE INFO

Article history:
Received 13 May 2012
Received in revised form 15 December 2013
Accepted 16 December 2013
Available online 28 December 2013

JEL classification:
F12
D23
L23

Keywords:
Multinational firms
Outsourcing
Intra-firm trade
Offshoring
Vertical FDI

ABSTRACT

We develop a theory of a firm in an incomplete contracts environment which decides on the complexity, the organization, and the global scale of its production process. Specifically, the firm decides i) how many intermediate inputs are simultaneously combined to a final product, ii) if the supplier of each input is an external contractor or an integrated affiliate, and iii) if that input is offshored to a foreign country. Our model leads to a rich set of predictions on the internal structure of multinational firms. In particular, it provides an explanation why many firms choose *hybrid sourcing* and have both outsourced and integrated suppliers.

1. Introduction

Research in international trade has revealed the existence of substantial firm-level heterogeneity even within narrowly defined industries. The literature was first concerned with the comparison of firms that only sell locally with exporting firms which also serve foreign markets. More recent studies then emphasized that firms also differ markedly in the their *importing* behaviors, and more generally, in their sourcing strategies for intermediate inputs.[1]

In this paper, we highlight three important dimensions along which firms' sourcing strategies differ. Specifically, we develop a theory of a firm where the headquarter (the "producer") decides on i) *complexity*: the mass of intermediate inputs – each provided by a separate supplier – that are simultaneously combined in the production process for a final good, ii) *organization*: if the supplier of each component is an external subcontractor or an integrated subsidiary, and iii) *global scale*: if the supplier is domestic or foreign.

Our model builds on the seminal approaches by Antràs (2003), Acemoglu et al. (2007) and Antràs and Helpman (2004). The former two papers were the first to study global sourcing in a property rights framework with incomplete contracts. These models are, however, restricted to a setting with a headquarter and *one single* supplier. The latter paper considers an endogenous mass of suppliers. The more inputs are combined in the production process, the more specialized is the task that each single supplier performs and the finer is the division of labor inside the firm. However, in Acemoglu et al. (2007) there are only symmetric firm structures where either all suppliers are integrated or all are outsourced. We extend their framework and allow for *hybrid sourcing*, that is, for a firm structure where *some* suppliers are vertically integrated while the others remain independent, and where *some* inputs are offshored while the others are produced domestically. This, in turn, endogenously generates asymmetries across suppliers in their bargaining powers and investment incentives. Thereby, our model leads to a rich set of predictions on the structure of multinational enterprises (MNEs) that are consistent with stylized facts from the recent empirical literature. It also leads to several novel testable predictions that may motivate future empirical research.

The recent empirical trade literature has shown that hybrid sourcing is a highly relevant phenomenon. For example, Defever and Toubal (2013) observe that in 1999 only about 8% of all French MNEs in the largely globalized motor vehicle industry (e.g., Iveco and Molsheim) have imported intermediates exclusively from related parties, 47% of

☆ We thank Pol Antràs (the editor), two anonymous referees, Bruce Blonigen, Gregory Corcos, Fabrice Defever, Giordano Mion, Peter Neary, Gianmarco Ottaviano, Uwe Stroinski, seminar participants in Tübingen, Göttingen, Nottingham, and participants at the 2011 CESifo Summer Institute in Venice and the 2010 European Trade Study Group (ETSG) in Lausanne for helpful comments and suggestions. All errors and shortcomings are solely our responsibility.

* Corresponding author at: Düsseldorf Institute for Competition Economics (DICE), Heinrich-Heine-University Düsseldorf, CESifo and IZA, Universitätsstrasse 1, 40225 Düsseldorf, Germany. Tel.: +49 211 81 11839.
E-mail address: suedekum@dice.hhu.de (J. Suedekum).

[1] See Bernard et al. (2010, 2012) for recent overviews how firms engaged in exporting and global sourcing differ from firms that only sell and source domestically.

0022-1996/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jinteco.2013.12.006

them (e.g., Heuliez Bus and Smart Car) have imported exclusively from external foreign suppliers, while the remaining 45% have chosen some combination of outsourcing and vertical integration. When it comes to the important "make or buy" decision, we thus observe that there is often a co-existence of different sourcing modes for different inputs within the same firm. Such a pattern is also found, among others, by Costinot et al. (2013), Corcos et al. (2013), Kohler and Smolka (2012) and Tomiura (2007) for US, French, Spanish, and Japanese firms, respectively. Hybrid sourcing also spans the *global scale* dimension. Baldwin (2009), for instance, discusses the case of the "Swedish" car *Volvo S40*. He illustrates that Volvo chooses to offshore only *some* intermediate inputs while relying on domestic manufacturing for others, and for the offshored components the firm relies on a mix of arm's length outsourcing and intra-firm trade.[2]

With respect to the *complexity* dimension, evidence is more scarce since current data typically only allows to observe supplier relationships where the parent firm owns a majority share of the input provider, whereas the number of external supplier relationships is not observable. Given this caveat, the available recent evidence still suggests that firms differ vastly in their complexity. For example, Alfaro and Charlton (2009) report that the *General Motors Corporation* (GM) can be traced as the ultimate owner ("global ultimate parent") of 2248 firm entities, 455 of which are subsidiaries outside the USA and 123 are in manufacturing industries. Of those 123 affiliates, Alfaro and Charlton (2009) classify 43 to be input suppliers providing manufacturing components for GM's final products. By comparison, using similar but more comprehensive data for roughly 300,000 business groups worldwide, Altomonte and Rungi (2013) report that the average US headquarter firm owns just 21 affiliates, only some of which can be classified as input suppliers.[3] In addition, more than 50% of those headquarters have less than four affiliates, and are thus far less "complex" than the GM business group.

Summing up, both within and across industries, there is substantial heterogeneity with respect to the *complexity*, *organization* and *global scale* of firms' internal structures. Understanding those patterns in the data requires a theoretical model with multiple suppliers which can be asymmetric in their organizational mode and their country of origin. Our framework can address those facts. It provides an economic theory on the firm- and industry-level determinants of those firm structure decisions, and it provides an explanation why firms often choose different organizational and global scale modes for some inputs than for others.[4]

Importantly, hybrid sourcing can arise in our model even though all inputs are symmetric along all exogenous dimensions. That is, our model does not rely on supplier heterogeneity, but our key results are driven by the fact that the headquarter can use the firm structure decisions to fine-tune the revenue distribution inside the firm, and thereby the incentives of all involved parties to invest into the relationship. This mechanism is different from the one operating in the recent framework by Antràs and Chor (2013). They consider a vertical value chain (a *snake* structure in the terminology of Baldwin and Venables (2013)), where inputs differ ex ante by their level of "downstreamness". Our model considers a *spider* structure, where many inputs are combined simultaneously, and puts forward an explanation why the firm may organize some "legs" of that spider differently than others.

This paper is organized as follows. Section 2 presents our basic model structure. Section 3 focuses on the complexity and organizational decisions in a closed economy setup. Section 4 turns to the open economy and introduces the global scale decision. Section 5 concludes.

2. Model

2.1. Demand, technology and firm structure

We consider a firm that produces a final good q for which it faces the following iso-elastic demand function:

$$q = A \cdot p^{-1(1-\beta)}. \tag{1}$$

Here, p denotes the price, and $A > 1$ is an exogenous term that captures the market size for this final product. The demand elasticity is $1/(1-\beta)$, which is increasing in $\beta \in [0, 1]$. Producing this good requires headquarter services and manufacturing components, which are combined according to the following Cobb–Douglas production function:

$$q = h^{\eta} \cdot \left(\int_{j=0}^{N} x(j)^{\alpha} \mathrm{d}j \right)^{\frac{1-\eta}{\alpha}}. \tag{2}$$

Headquarter services are denoted by h and are provided by the "producer". The parameter $\eta \in [0,1]$ is the headquarter-intensity of final goods production.[5] For the components, we assume that there is a continuum of inputs with measure $N \in \mathbb{R}_+$, where each component is provided by a separate supplier. The supplier $j \in [0, N]$ delivers $x(j)$ units of his particular input, and the components are aggregated according to a constant elasticity of substitution (CES) function where $\alpha \in [0, 1]$ measures the degree of component substitutability. Using Eqs. (1) and (2), total revenue can then be written as follows:

$$R = A^{1-\beta} \cdot h^{\beta\eta} \cdot \left(\int_{j=0}^{N} x(j)^{\alpha} \mathrm{d}j \right)^{\gamma} \quad \text{where} \quad \gamma \equiv \frac{\beta(1-\eta)}{\alpha}. \tag{3}$$

In our model, the producer decides on the structure of the firm, and this choice involves three aspects: *complexity*, *organization*, and *global scale* of production.

The *complexity* choice refers to the mass of components N. From Eq. (2) it is clear that the overall component-intensity of final goods production is exogenously given by $1-\eta$. This parameter reflects the technology of the sector in which the firm operates. When the producer chooses N, she thus essentially decides on the division of labor inside the firm. The larger N is, the narrower is the task that each single supplier performs, and the more complex is the firm's production process.[6] We assume that a greater mass of suppliers induces agency costs vN for managerial oversight, where $v > 0$ is the fixed cost per additional supplier.

Turning to the *organizational* decision, the producer decides separately for each of those components if the respective supplier is integrated as a subsidiary within the boundaries of the firm, or if that component is outsourced to an external supplier. Following the property rights approach of the firm à la Grossman and Hart (1986) and Hart and

[2] Further examples for MNEs' sourcing strategies are discussed in Antràs and Rossi-Hansberg, (2009) and Antràs (2013). Partial offshoring can also arise in the model by Grossman and Rossi-Hansberg (2008). They do, however, not analyze different organizational modes for supplier relationships.

[3] Even if it is not directly observable in the data, big corporations like GM are likely to have not only more affiliates than the average US firm in the same sector, but also more unrelated suppliers with whom they contract via market transactions.

[4] A different extension of the Antràs and Helpman (2004) framework with more than one supplier is due to Du et al. (2009). In their model, the *same* input can be provided by two suppliers, and "bi-sourcing" (one supplier integrated and the other outsourced) can arise out of a strategic motive, because it systematically improves the headquarter's outside option. In our model there is an endogenous mass of suppliers who provide differentiated inputs, and our hybrid sourcing result relies on a different motive. Van Biesebroeck and Zhang (2011) also study an incomplete contracts model with a headquarter and multiple suppliers. However, they do not consider an endogenous complexity choice and focus on the organizational form of outsourcing. Last, Nowak et al. (2012) study a global sourcing model with *two* asymmetric, discrete suppliers and thus also disregard the endogenous complexity decision.

[5] The headquarter services thus account for a fixed share η of total value added and necessarily have to be performed by the producer herself, i.e., they cannot be unbundled, outsourced or offshored.

[6] This complexity choice is thus closely related to Acemoglu et al.'s (2007) notion of the firm's *technology*.