

**Volume 31, Issue 1****Global sourcing – a critical reconsideration of sector definitions**

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**Abstract**

I introduce an alternative parameter-based definition of component- and headquarter-intensive sectors into the seminal model of global sourcing by Antràs and Helpman (2004, JPE). This approach overcomes problems of the original sector definition like counter intuitive classifications or industries that are not classified as either component- or headquarter-intensive. The strong empirical evidence for the model's predictions is also based on a similar sector definition. With a numerical approach I show that a richer set of sourcing modes can arise in equilibrium. Nonetheless, the main results of Antràs and Helpman are robust.

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# 1 Introduction

In their seminal contribution Antràs and Helpman (2004) introduce a North-South model of international trade where firms choose from a variety of organizational forms, depending on their individual productivity and sector characteristics. Their framework, which combines firm heterogeneity in spirit of Melitz (2003) with organizational structures as in Antràs (2003), is especially helpful for coming to grips with newly emerged empirical facts about arm's length outsourcing and intra-firm trade. The main result by Antràs and Helpman is that firms in headquarter-intensive sectors are more likely to choose integration strategies, whereas in component-intensive sectors they solely focus on outsourcing strategies.

To derive their main result Antràs and Helpman (2004) study how the contract choice varies for different levels of productivity, given the following two exogenous parameters: i.) the headquarter intensity (i.e., the headquarter's input share in the assumed Cobb-Douglas production function) and ii.) the share of ex post gains from the contract relationship (i.e., the bargaining power of the final-good producer). The derivation of their main result is potentially problematic, however, because their sector cutoffs solely focus on only one of the two parameters, the headquarter's input share. This leads to the fact that sectors with a very low (high) factor share in components may actually be defined as component-intensive (headquarter-intensive). Furthermore and more importantly, the parameter regions classified as either component- or headquarter-intensive may be quite small. I consider it intuitive to define a sector as component-intensive when the exogenous factor share of components is high, and vice versa. With my parameter-based definition all possible sectors can be classified without having to refer to the ex post gains.

Empirical evidence for sourcing modes of multinational firms is scarce due to the fact that firm-level data on outsourcing is rare. Nevertheless, recent empirical literature on multinational firms provides strong empirical evidence for the theoretical predictions of the Antràs and Helpman model.<sup>1</sup> However, since the ex post gains from the contract relationship are hard to observe those studies also rely on a parameter-based sector definition. With the alternative sector definitions the main results of Antràs and Helpman remain robust. Using numerical methods I derive the organizational forms in equilibrium. In sectors with low headquarter intensity firms tend to focus on outsourcing while in sectors with high headquarter intensity a coexistence of integration and outsourcing prevails. Concerning the location high productive firms tend to engage in foreign sourcing while the low productive firms centre the production in their home country. Yet, my approach allows for a richer menu of possible outcomes. For example, I discover that firms may choose an integration strategy although the sector is component-intensive. Hence, the original classification where only outsourcing prevails in component-intensive sectors may be misleading as to the relationship between firm productivity and contract choice.

## 2 Analysis

I start with a brief review of the Antràs and Helpman model. Output  $x$  of the final-good is given by a Cobb-Douglas type production function

$$x = \theta \cdot \left(\frac{h}{\eta}\right)^\eta \cdot \left(\frac{m}{1-\eta}\right)^{1-\eta} \quad \text{with } \eta \in (0, 1) \quad (1)$$

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<sup>1</sup>See Feenstra and Hanson (2005), Yeaple (2006), Defever, and Toubal (2007), Tomiura (2007), Nunn and Trefler (2008), Jabbour (2008), Corcos et al. (2008), Kohler and Smolka (2009), Alfaro and Charlton (2009), Bernard et al. (2010) and Federico (2010) for recent empirical studies.

and depends on the two inputs headquarter services  $h$  and manufactured components  $m$ . The productivity  $\theta$  is firm-specific whereas the sector specific parameter  $\eta$  is the input intensity in headquarter services. Headquarter services  $h$  can exclusively be provided by the final-good producer while for the production of the component  $m$  the final-good producer faces a two dimensional decision. Firstly, component production can be integrated within the boundaries of the firm or outsourced to an unaffiliated supplier. Secondly, component production can be accomplished in the domestic or a foreign country.

The final-good producer's share  $\beta$  of ex post gains differs for the sourcing modes. The final-good producer receives a higher fraction in case of integration than under outsourcing. When integration takes place, this fraction is lower in the foreign country than in the home country. The ranking of the ex post shares is given by

$$\beta_V^N = (\delta^N)^\alpha + \beta [1 - (\delta^N)^\alpha] \geq \beta_V^S = (\delta^S)^\alpha + \beta [1 - (\delta^S)^\alpha] > \beta_O^S = \beta_O^N = \beta \quad (2)$$

with  $\alpha \in (0, 1)$  and  $1 > \delta^N \geq \delta^S > 0$ . The index  $V$  and  $O$  indicates whether the intermediate input production is integrated ( $V$ ) or outsourced ( $O$ ). Foreign production is denoted by  $S$  while domestic production is denoted by  $N$ . If the final-good producer could freely choose the fraction  $\beta^*(\eta)$  that maximizes the total value of the relationship (total revenue),  $\beta^*(\eta)$  would be given by

$$\beta^*(\eta) = \frac{\eta(\alpha\eta + 1 - \alpha) - \sqrt{\eta(1 - \eta)(1 - \alpha\eta)(1 + \alpha\eta - \alpha)}}{2\eta - 1}. \quad (3)$$

Antràs and Helpman define a sector as component intensive (see p.565) whenever the headquarter-intensity  $\eta$  is so small, such that  $\beta > \beta^*(\eta)$  holds. A sector is considered headquarter intensive (see p.567) whenever  $\eta$  is large enough such that  $\beta^*(\eta) > \beta_V^N$  holds. I use the ordering of revenue shares (2) to rearrange the condition  $\beta^*(\eta) > \beta_V^N$ , which is then equivalent to

$$\beta < \frac{\beta^*(\eta) - (\delta^N)^\alpha}{1 - (\delta^N)^\alpha} \equiv \bar{\beta}(\eta). \quad (4)$$

Each possible sector is a point in the  $(\beta, \eta)$  plane. The set of sectors is therefore the whole surface indicated in Figure 1. I provide  $\beta^*(\eta)$  and  $\bar{\beta}(\eta)$  in Figure 1 to illustrate the two main theoretical criticisms of the sector definitions: Firstly, it is obvious that for medium levels of  $\eta$  and  $\beta$  no sector classification as Antràs and Helpman propose is valid. Take for example point  $X$  where both conditions  $\beta > \beta^*(\eta)$  and  $\beta^*(\eta) > \beta_V^N$  are simultaneously violated. Secondly, the definition of sectors can lead to a quite counterintuitive classification of sectors. Consider, e.g., the point  $Y$  in Figure 1. Antràs and Helpman would consider this sector as component-intensive, even though the headquarter-intensity  $\eta$  is very high. It is natural to argue that the set of sectors which are not classified have medium levels of headquarter intensity  $\eta$ . Hence, it is suggestive to only consider sectors with either a very high or a very low headquarter intensity. However, since  $\lim_{\eta \rightarrow 0, \eta \rightarrow 1} \partial\beta^*/\partial\eta \rightarrow \infty$ , an arbitrary small change in  $\eta$  may lead to a switch in the sector classification. Take for example point  $A$  and  $B$  in Figure 1. The sector associated with point  $A$  is component-intensive although only a small increase in  $\eta$  to point  $B$  leads to a sector switch.<sup>2</sup>

<sup>2</sup>However, it is clear that for any cutoff in continuous parameter space an infinitesimal parameter change can alter the resulting sector classification.

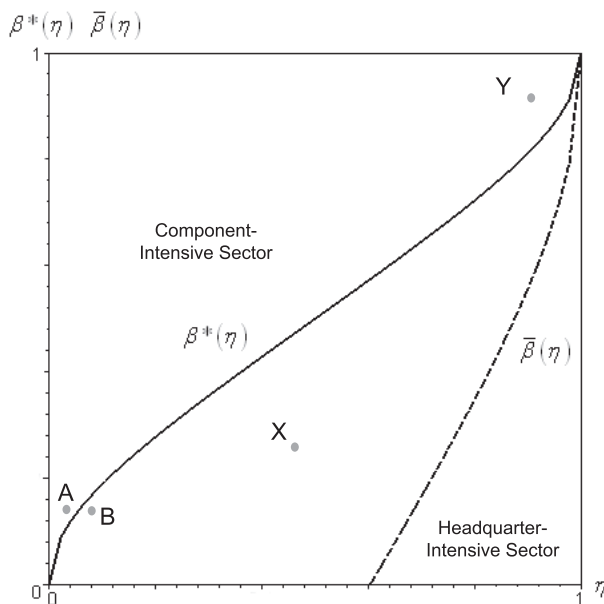


Figure 1: Sector classifications

## 2.1 Parameter-based sector definitions

Due to the rationale above, I propose an alternative parameter-based definition of sectors. I consider it intuitive to define a sector as component intensive when the exogenous factor share of components is high, i.e. if  $\eta < 0.5$ . A sector is defined headquarter-intensive when it is not component-intensive. This definition of sectors avoids counter intuitive sector characterizations and classifies each sector. The empirical evidence for the model's predictions are also based on an parameter-based sector definition. I call the following numerical example "benchmark" case since all sorting patterns Antràs and Helpman derive for their headquarter- and component-intensive sector are incorporated. Figure 2 depicts for each  $(\beta, \theta)$  pair the sourcing mode with the highest profits.<sup>3</sup>

Consider the left graph in Figure 2 with  $\eta = 0.25$ . For a  $\beta$  within the black bars  $\beta > \beta^*$  is fulfilled and this is the case which Antràs and Helpman consider as their component-intensive sector. All firms that do not immediately exit due to a low productivity draw  $\theta$  choose either domestic or foreign outsourcing. The relatively more productive firms within these bars outsource in the foreign country (see, e.g., point  $X$ ) and the not so productive firms outsource domestically (see, e.g., point  $Y$ ). Notice however, that a richer pattern of possible sourcing modes is valid. In particular, if  $\beta$  is below the lower bound of the bars even in component-intensive sectors firms may choose integration strategies (see, e.g., point  $Z$ ). Next, I discuss the headquarter-intensive sector. Consider the right graph in Figure 2 with  $\eta = 0.75$ . For a  $\beta$  within the black bars the sorting pattern is identical to the one Antràs and Helpman identify for the headquarter-intensive sector. The most productive firms use foreign direct investment while slightly less productive firms use foreign outsourcing. Within the home country the relatively low productive firms use outsourcing while the high productive firms integrate. Yet again, a richer set of possible organizational forms can arise in equilibrium. In particular, if  $\beta$  is high even

<sup>3</sup>I use  $\eta = 0.25$  for the component-intensive sector and  $\eta = 0.75$  for the headquarter-intensive sector. Other parameters:  $f_V^S = 0.15$ ,  $f_O^S = 0.095$ ,  $f_V^N = 0.05$ ,  $f_O^N = 0.025$ ,  $\omega^N = 1$ ,  $\omega^S = 0.7$ ,  $\delta^N = 0.5$ ,  $\delta^S = 0.4$  and  $\alpha = 0.75$ .

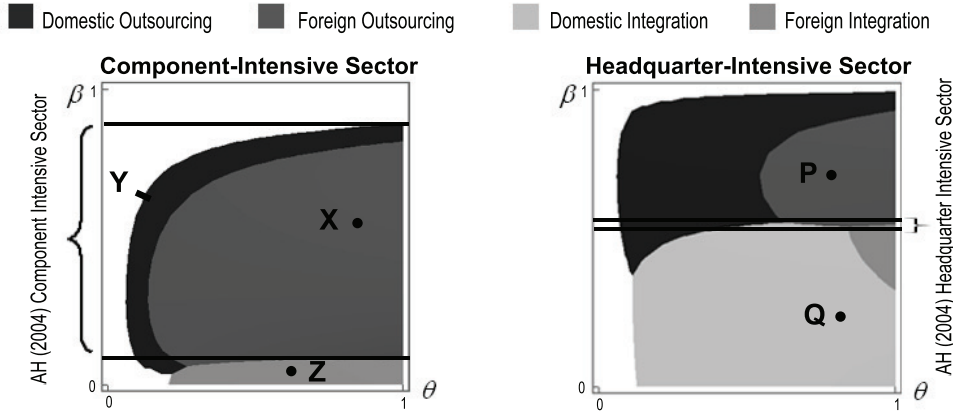


Figure 2: Profit maximizing sourcing modes

in headquarter-intensive sectors firms may only choose outsourcing strategies (e.g., point  $P$ ). If  $\beta$  is below the lower bounds of the bars firms may solely focus on integration (e.g., point  $Q$ ). Hence, a sufficiently low  $\beta$  leads to integration regardless of the headquarter intensity  $\eta$ . In this case  $\beta^* > \beta_V^N \geq \beta_V^S > \beta_O^S = \beta_O^N = \beta$  holds and the final-good producer supplies less than efficient headquarter services, regardless of the contract choice. This underinvestment problem is magnified in case of outsourcing and relatively less severe with integration. In both benchmark sectors sufficiently high productive firms offshore the component production.<sup>4</sup>

### 3 Conclusion

The numerical results illustrate that the prevalence of integration strategies increases with the headquarter intensity. For a given bargaining power  $\beta$  and input intensity  $\eta$  sufficiently high productive firms prefer foreign sourcing while the low productive firms focus on domestic production. Yet, my approach delivers a richer set of possible outcomes. I find, e.g., that firms in component-intensive sectors may also choose integration strategies if  $\beta$  is sufficiently low. This leads to the fact that the original sector classification may be misleading as to the relationship between firm productivity and contract choice.

My results have direct implications for the related empirical studies. Due to the fact that the bargaining powers are hard to observe, empirical studies that examine the theoretical predictions of the model also rely on an parameter-based sector definition. They find strong empirical evidence for the prediction that foreign integration is largest when both headquarter intensity and productivity is high.

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<sup>4</sup>Note that both graphs of Figure 2 could be easily drawn for higher levels of productivity. In this case foreign sourcing dominates domestic sourcing for every given  $\beta$ . However, the graphical indication of the Antràs and Helpman headquarter-intensive sector would then be unnecessarily tiny.

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