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Plausible Deniability: Integration vs. Outsourcing with Heterogeneous Firms and Unethical Suppliers*

Claudius Löhnert†

March 2022

Abstract

This paper presents a property rights model of the international organization of production, where heterogeneous headquarter firms source from suppliers in the Global South. Due to weak regulatory stringency in the Global South, suppliers can employ a cost-saving technology. Consumers, however, consider this technology as *unethical* and may therefore participate in a consumer boycott, if they consider a firm to be responsible for its supplier's conduct. The paper analyzes how the international organization of production and the choice of technology interact with each other as well as sectoral characteristics. It identifies three mechanisms that govern whether integration is preferred by high-productivity firms in a given sector: the Antràs mechanism (severity of underinvestment by headquarter vs. supplier), the unethical mechanism (cost savings vs. boycott risk) and the deniability mechanism (higher boycott risk under integration than under outsourcing). The equilibrium share of active firms who integrate in a sector increases with productivity dispersion and decreases in the sector's cost advantage of unethical production.

Keywords: international outsourcing, property rights theory, heterogeneous firms, ethical production, consumer boycotts, NGOs, social activism.

JEL Classification: D23, F12, F23, F61, L11, L23, L31, O35.

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1. Introduction

The international fragmentation of production (see Baldwin 2016) gives firms an opportunity to cut costs by sourcing from the Global South, where they face not only lower wage levels but also a laxer regulatory environment.[1] The latter allows foreign suppliers to employ cost-saving production practices that are prohibited in the Global North, because they exert negative externalities on third parties.[2] In recent decades, rising social activism has increased consumer awareness for such issues, leading to a backlash against firms employing technologies that consumers consider "unethical".[3] When this backlash escalates into consumer boycotts, the cost-savings from using allegedly unethical technologies need to be traded off against the potential loss of revenue. It is a common response of firms confronted with issues in their value chain to deny knowledge of and responsibility for unethical conduct by their suppliers, e.g., by pointing out that the suppliers violated corporate codes of conduct. The plausibility of such claims, however, hinges on the relationship between headquarter firm and foreign supplier: a firm with a vertically integrated supplier is less credible when denying responsibility for the supplier's actions than a firm that sources from an independent supplier. Thus, headquarter firms' choices regarding the mode of ownership in their value chains interact with the risks and benefits of employing cost-saving technologies.

This paper puts the interaction of firms' organizational forms with the technology choice by their suppliers at center stage. It analyzes how the prevalence of integration vs. outsourcing in a given sector is related to sectoral characteristics such as headquarter intensity, productivity dispersion as well as – most importantly – incentives for unethical production.

The model utilizes the property rights theory to analyze the international organization of production. It models the interaction between heterogeneous headquarter firms and their foreign suppliers, which may employ cost-saving technologies that consumers consider as unethical.[4] In case of unethical production, the firm may be hit by a consumer boycott, if it cannot plausibly deny responsibility for the unethical conduct.

In the model, the trade-off between boycott risk and sectoral cost advantage of unethical production gives rise to a typology of sectors: in sectors with particularly strong (weak)

[1] For example, see Copeland & Taylor (2004) for the *pollution haven effect* due to differences in environmental policies and Javorcik & Spatareanu (2005) for effects of labor market regulation on FDI inflows.

[2] A very well-documented example (e.g., Harrison & Scorse 2010) is the case of Nike in the 1990s with deficient working conditions at Indonesian suppliers. In other cases, negative externalities have consequences for the environment; for example, a palm oil supplier of Nestlé is accused of contributing to rainforest destruction (Greenpeace 2010).

[3] In the case of Nike from footnote 2, the company was target of substantial negative campaigns. Herkenhoff & Krautheim (2022) (and references therein) present many more examples of firms that faced consumer boycotts due to "unethical" infringements on the part of their suppliers.

[4] This paper is agnostic about what constitutes an "unethical" technology. The only relevant criterion is that consumers *perceive* certain cost-saving practices as unethical.

cost advantages of unethical production, suppliers always (never) opt for the unethical technology. Sectors with intermediate cost advantage levels, however, may simultaneously host ethical as well as unethical suppliers, where a supplier's technology choice depends on the ownership structure of the firm.

The paper identifies three mechanisms that incentivize the choice of organizational form made by the headquarter firm: the *Antràs mechanism*, which is well-known from the literature on incomplete contracts and concerns the severity of underinvestment by headquarter vs. supplier; the *unethical mechanism*, which captures the trade-off between boycott risk and cost savings if the supplier's technology choice depends on the mode of ownership; and the *deniability mechanism*, which reflects the increased boycott risk when integrating an unethical supplier. Based on these three mechanisms, the model presents a characterization of sectors according to whether the interplay of a sector's headquarter intensity of final goods production and cost advantage of unethical production makes high-productivity firms prefer integrating their suppliers over outsourcing.

Finally, it is analyzed how in an equilibrium with free entry of firms, the prevalence of organizational forms is related to the cost advantage of unethical production, the sectoral productivity dispersion and the strength of the deniability mechanism. The share of active firms who choose integration (weakly) decreases in the cost advantage of unethical production and increases with productivity dispersion.

This paper is rooted on the premise of incomplete contracts, in the spirit of the literature building on Antràs (2003). Two important sources of contractual incompleteness in this literature are that it is infeasible or prohibitively costly to specify all possible contingencies in a contract and that contract enforcement may not be possible, especially in international transactions. Antràs (2015) discusses such sources of contractual incompleteness in detail and provides many illustrative examples. In line with this literature, the paper assumes that it is not possible to enter contracts that specify the investments into intermediate products by headquarter or supplier – and that this applies even if the supplier is a vertically integrated part of the headquarter firm. It is further assumed that this reasoning applies to the choice of the supplier's technology as well. This is even consistent if one considers production technology as a property that is observable and can be specified in a contract, as long as it remains "observable, but not verifiable" (Hart & Moore 1999, p. 118), which prevents enforcement of any contractual agreements on the production technology to be employed. This is supported by empirical evidence of widespread violations of codes of conduct by supplier firms (e.g., Short, Toffel & Hugill 2016, 2020). While such violations – like not abiding to workplace safety standards, employing child labor, forced overtime, poor treatment of animals or practices that are harmful to the environment – may be observable by the general public, gathering evidence that is verifiable in court can still be prohibitively difficult and hence prevent enforcement. Two recent studies where suppliers take observable but unverifiable decisions are Herkenhoff & Krautheim (2022)

with a non-contractible technology choice and Herkenhoff, Krautheim, Semrau & Steglich (2021) with non-contractible CSR investments. Both studies provide further discussion and examples.

A second premise relates to the link of unethical technology and consumer boycotts. The assumption is that when consumers become aware that a supplier has used unethical technology, they participate in a consumer boycott against the final goods producer if the latter is considered responsible for the unethical infringement.[5] A large number of examples where unethical conduct sparked consumer boycotts are documented in Baron (2012), Krautheim & Verdier (2016) and Herkenhoff & Krautheim (2022). The probability whether consumers consider a final goods producer responsible for the use of unethical technology by a supplier is assumed to be a function of the organizational structure of the firm: if the firm sources inputs from an independent supplier, it may plausibly deny responsibility for the supplier's choice of technology. Lines of defense could be that the supplier acted in violation of the corporate code of conduct or that the firm was not aware of the unethical actions. Such arguments, however, are less credible if the supplier is a vertically integrated part of the firm. This motivates the modeling feature that the probability of a consumer boycott is lower when sourcing from an independent unethical supplier, as compared to unethical intra-firm trade with an integrated supplier.

The model considers the international organization of production under incomplete contracts, building on Antràs & Helpman (2004). Heterogeneous headquarter firms H, who operate under monopolistic competition with free entry in the Global North, contract with homogeneous suppliers M in the Global South. Both agents provide relationship-specific inputs for the production of final goods (headquarter services and manufacturing inputs, respectively). Once H and M have made their relationship-specific investments, their relationship is *fundamentally transformed* (see Williamson 1985, pp. 61 ff.) into a bilateral monopoly, because each parties' investment is useless without the input provided by the other agent – i.e., they are *locked-in*. This gives rise to a bilateral holdup problem, which is resolved in a generalized Nash bargaining game where headquarter and supplier negotiate the distribution of revenue. Anticipating that bargaining, both agents choose their initial investments noncooperatively, which leads to underinvestment in both inputs.

A central trade-off in the model is the headquarter's decision to integrate its supplier or to keep it at arm's length. Following the property rights theory, the mode of ownership assigns residual rights of control, in this case control over the input produced by the

[5] The central assumption is that unethical firms are not subject to a consumer boycott with certainty, because consumers accept the firms' denial of responsibility with positive probability. In this case, it does not matter whether consumers directly observe the technology or if the technology used in production is a credence characteristic of the final good, which is only probabilistically revealed to consumers. While the latter notion is the assumption made in Herkenhoff & Krautheim (2022), this paper assumes that technology is observable. Due to the element of probabilistic deniability in this paper, incorporating such a second layer of uncertainty (technology being revealed only with some probability) would be redundant, although the model could easily be extended in that respect.

supplier: by vertically integrating M, the headquarter buys the right to seize the supplier's input if bargaining fails. This increases the headquarter's outside option in the bargaining game, which gives H more bargaining power in the negotiation with M and therefore leads to the allocation of a larger share of revenue to H. Yet, integration also has downsides: Not only is integration assumed to entail higher fixed costs of organizing production, but being in a weaker bargaining position decreases the supplier's incentive to invest, exacerbating its underinvestment. At the same time, there is less underinvestment by H under integration. This trade-off will be referred to as the *Antràs mechanism*. Which of these two effects dominates depends on the headquarter intensity of the final good: The higher (lower) the level of headquarter intensity, the more severe is the impact of underinvestment by H (M), fostering integration in sectors with high headquarter intensities and outsourcing in others.

The second key trade-off in the model is the choice of technology (ethical or unethical) by the supplier, which is modeled along the lines of Herkenhoff & Krautheim (2022). If M chooses unethical technology, this reduces its marginal costs, but exposes the firm to the risk of being targeted by a consumer boycott, putting its revenue at stake. The supplier therefore needs to trade off the cost savings of unethical production against the expected loss of (its share of) revenue.

The two trade-offs become interrelated to each other through the deniability feature of consumer boycotts: A firm with an unethical supplier can more plausibly deny responsibility for the supplier's unethical conduct if the supplier is independent, leading to a higher boycott probability in case of unethical production under integration. This makes the supplier's choice of technology potentially contingent on the mode of organization – and incorporates considerations of unethical production into the headquarter's choice of organizational form.

For the supplier, the increased boycott probability under integration implies that under integration, unethical production only pays at stronger cost advantages of unethical technology than under outsourcing. As a result, there are three types of sectors: sectors with very strong cost advantages of unethical production, where the supplier produces always unethically; sectors with very weak cost advantages of unethical production, where only ethical production takes place; and sectors with intermediate cost advantages of unethical production such that the supplier is ethical under integration but unethical under outsourcing.

For the headquarter, the dependence of the boycott probability on the choice of organizational form implies that the latter is not only determined by the Antràs mechanism outlined above, but also by incentives that stem from the possibility of unethical production: In sectors where the supplier's choice of technology is contingent on the mode of ownership, the headquarter, too, has to weigh the cost advantage of unethical production against the boycott risk. In these cases, this *unethical mechanism* combined with the Antràs

mechanism incentivizes the integration vs. outsourcing decision. In sectors where the supplier produces unethically with certainty, the *deniability mechanism* becomes active: Even if the Antràs mechanism calls for integration, this needs to be traded off against the decreased deniability and hence higher boycott risk under integration.

The focus of the analysis is on setups where the equilibrium organization of production simultaneously supports integration as well as outsourcing. This requires that the Antràs mechanism sufficiently strongly incentivizes integration, which is the case for sufficiently high headquarter intensities. At the same time, a large enough fixed cost differential between integration and outsourcing needs to ensure that not all surviving entrants integrate. In this so-called *benchmark scenario*, low-productivity firms exit, high-productivity firms integrate and firms with intermediate productivities choose outsourcing. While this pattern applies to all sectors independently of their cost advantages of unethical production, the share of active firms who integrate is lowest in sectors where all suppliers produce unethically, it is highest in sectors where all suppliers produce ethically and it decreases in the cost advantage of unethical production if suppliers produce ethically under integration but unethically under integration. Ceteris paribus, this share is higher in sectors with more productivity dispersion and it (weakly) increases if the effect of deniability rises.

This paper contributes to the extensive literature on the structure of international trade that has been surveyed in Antràs & Yeaple (2014). Specifically, it belongs to the strand of literature that applies the property rights theory (as pioneered by Grossman & Hart (1986) and Hart & Moore (1990), recently summarized in Hart (2017)) to the analysis of the international organization of production under incomplete contracts, following the seminal contribution by Antràs (2003). Recent developments in this literature are presented in Antràs (2015) as well as – in the broader context of global value chains – in Antràs & Chor (2022, in particular section 5). Closest to this paper is Antràs & Helpman (2004), where heterogeneous headquarter firms source inputs from supplier firms. In doing so, they face two trade-offs: they choose the location of the supplier and the mode of ownership. While the mode of ownership (integration vs. outsourcing) affects property rights and therefore incentives to invest under integration, the location choice affects variable costs (as well as outside options in the ex-post bargaining under integration). This paper adopts the modeling framework of Antràs & Helpman (2004) to study the interaction of a technology choice and the choice of organizational forms. To this end, it restricts the location of suppliers to the Global South, thus eliminating the location choice from Antràs & Helpman (2004) and making the analysis of the additional trade-offs that stem from the (unethical) technology choice tractable.

By considering consumer boycotts in response to unethical production in the Global South, the model is connected to an emerging literature in International Economics that

relates to discontent with economic globalization, e.g. Pavcnik (2017), Egger & Fischer (2020), Harms & Schwab (2020) and Grossman & Helpman (2021) as well as the recent survey in Colantone, Ottaviano & Stanig (2022) on the "backlash against globalization." More specifically, consumer boycotts and other forms of interactions between activists and firms have been studied in a large literature on *private politics*, that builds on Baron (2001, 2003).[6]

While the literature on private politics is rooted in Industrial Organization, there is a growing literature that introduces elements of social activism from the private politics literature into International Economics. Early contributions include Aldashev & Verdier (2009), Kitzmueller (2012), Aldashev, Limardi & Verdier (2015) and Krautheim & Verdier (2016). More recently, Koenig, Krautheim, Löhnert & Verdier (2021) study how the internationalization of trade and sourcing internationalizes social activism; and Herkenhoff et al. (2021) consider CSR investments within a firm's value chain that affect how consumers perceive the ethical quality of the final good. This paper contributes to that literature. It is most directly related to Herkenhoff & Krautheim (2022), who build on the framework of Antràs (2003) to analyze the international organization of production. Suppliers can choose an unethical cost-saving technology, which constitutes a credence characteristic of the final good, i.e., is not directly observable to consumers. However, if an unethical firm is revealed, it faces a consumer boycott with certainty. This mechanism forces unethical firms to mimic prices and quantities set by ethical firms. This paper adopts the possibility of unethical production and consumer boycotts from Herkenhoff & Krautheim (2022) and embeds them into the framework of Antràs & Helpman (2004) with multiple sectors, heterogeneous firms and free entry. While the technology choice is observable, unethical firms only probabilistically face consumer boycotts as consumers might accept a firm's denial of responsibility (see footnote 5).

The remainder of the paper is structured as follows. Section 2 presents the setup of the model. Section 3 analyzes optimal choices of a given firm, solving the model via backwards induction. Section 4 moves the analysis to the sector level to consider how sectoral characteristics affect firm choices, closes the model and analyzes the equilibrium prevalence of organizational forms. Section 5 concludes.

2. Model Setup

This section presents the setup of the model. The model builds on Antràs & Helpman (2004) and adapts that paper's notation where possible, while incorporating the possibility of unethical production and consumer boycotts along the lines of Herkenhoff & Krautheim (2022).

[6] Further contributions to the literature on private politics are Innes (2006), Baron & Diermeier (2007), Baron (2010, 2012), Lyon & Salant (2013) and, more recently, Baron (2016), Egorov & Harstad (2017) as well as Daubanes & Rochet (2019).

The world consists of two regions, the North (N) and the South (S). There are $J \geq 1$ sectors producing differentiated goods under monopolistic competition as well as a homogeneous good sector. The homogeneous good (x_0) is used as numéraire and assumed to be produced using only labor and under perfect competition, both in the North and the South. Therefore, the wage rates in each region are equal to labor productivity in the homogeneous good sectors, denoted as w^N and w^S, respectively.

Production of each differentiated variety i requires two agents: a final-goods producer H that provides headquarter services $h_j(i)$ and a supplier M that provides a manufacturing input $m_j(i)$. The final-goods producer combines these two inputs into final output $x_j(i)$.

All consumers are located in the North. There is a unit measure of consumers with identical preferences summarized by the following utility function:

$$U = x_0 + \frac{1}{\mu} \sum_{j=1}^{J} X_j^{\mu}, \qquad 0 < \mu < 1, \tag{1}$$

where X_j is an index of aggregate consumption in sector j. This consumption index in sector j is given by

$$X_j = \left[\int x_j(i)^{\alpha} \, \mathbb{I}(i) \, \mathrm{d}i \right]^{\frac{1}{\alpha}}, \qquad 0 < \alpha < 1. \tag{2}$$

The consumption index is a standard CES aggregate, except for the indicator variable $\mathbb{I}(i)$, which drops to 0 if the producer of variety i faces a consumer boycott (further discussion below) and takes the value of 1 otherwise. The parameter α is an exogenous measure of substitutability between varieties; the elasticity of substitution is $\frac{1}{1-\alpha}$. To ensure that substitutability between varieties is larger than substitutability between differentiated products, it is assumed that $\mu < \alpha$. By equations (1) and (2), the inverse demand function for variety i in sector j is

$$p_j(i) = X_j^{\mu-\alpha} \, \mathbb{I}(i) \, x_j(i)^{\alpha-1}. \tag{3}$$

The remainder of this section chronologically outlines the production of differentiated varieties. While this provides an overview of the production process, details on the key stages are presented in section 3.

There is free entry into each of the J differentiated goods sectors. Potential entrants must pay an entry fee of $w^N f_E$ before drawing a productivity θ for their firm-specific variety i. Productivities are distributed according to the Pareto distribution

$$G_j(\theta) = 1 - \left(\frac{b_j}{\theta}\right)^{z_j}, \quad \text{where} \quad \theta \geq b_j > 0. \tag{4}$$

The shape parameter $z_j > 0$ is a (inverse) measure of the sectoral dispersion of productiv-

ities and $b_j > 0$ defines the minimum productivity. Upon observing their productivity, entrants either exit the industry or stay in the market as final-goods producers. As headquarter services can be produced only in the North, all these headquarter firms locate in the North.

Each headquarter firm H contracts with one supplier M. All suppliers are located in the South, where there is an unbounded pool of M agents. Contracts between H and M are incomplete. This applies to investments made by both agents as well as to the production technology employed by M, which is independently set by the supplier. The only enforceable provisions stipulated by the contract are an up-front participation fee paid or received by M and the organizational form $k \in \{V, O\}$: The supplier can either be owned by H (vertical integration, V) or remain independent (international outsourcing, O). Depending on the mode of ownership, the firm has to pay an additional fixed cost of organizing production, $w^N f_k$. It is assumed that integration entails higher fixed costs of organizing production than outsourcing: $f_V > f_O$. Section 3.4 analyzes the choice of organizational form.

Suppliers have access to two types of production technology: they either produce with marginal costs w^S or employ a cost-saving technology that reduces their marginal costs. The cost-saving technology exploits weak regulatory stringency in the South and is considered *unethical* by consumers (see footnote 4). Indexing the technology employed by $l \in \{e, u\}$, marginal costs of a supplier in sector j are given by $\nu_j^l w^S$: unethical technology (u) reduces marginal costs to $\nu_j^u w^S$ ($0 < \nu_j^u < 1$), whereas marginal costs with ethical technology (e) amount to w^S ($\nu_j^e = 1$). The parameter ν_j^u can therefore be interpreted as an inverse measure of the *cost advantage of unethical production* in sector j: low values of ν_j^u imply a strong cost advantage of the unethical technology, whereas the cost advantage is weak if ν_j^u is high. Importantly, even if the supplier is integrated, H has no influence on the technology employed by the supplier. The choice of technology is discussed in section 3.3.

Taking into account the organizational form $k \in \{V, O\}$ and the supplier's technology choice $l \in \{e, u\}$, both agents make their investments $h_j(i)$ and $m_j(i)$, respectively. As both of them are aware of the incomplete contract that governs their relationship, they make their investments noncooperatively, leading to underinvestment by both parties. Importantly, these investments are relationship-specific and therefore only valuable within the headquarter–supplier match. The maximization problems, investments and expected revenue are presented in section 3.2.

If the manufacturing input embodied in variety i is produced unethically, this may trigger a consumer boycott. Whether this is the case is revealed after investments are sunk. For tractability, boycotts are modeled as switching the indicator variable $\mathbb{I}(i)$ in equations (2) and (3) to 0, such that there is no demand for this variety. The probability

of a consumer boycott for any given firm is $(1 - \gamma_k^l)$, so γ_k^l can be understood as the *no-boycott* probability. It is determined by the firm's organizational form k and technology l: Ethical firms are never boycotted ($\gamma_V^e = \gamma_O^e = 1$). Unethical firms are boycotted with a positive probability ($\gamma_k^u < 1$), which is higher if the unethical supplier is integrated: $\gamma_V^u < \gamma_O^u$. This captures that a boycott is only triggered if the headquarter cannot plausibly deny responsibility for the unethical conduct, which is less likely under integration.

Before M hands over the manufacturing input to H, both enter a bargaining over the distribution of revenue. The bargaining is shaped by the outside options of either party and therefore depends on the organizational form chosen by the headquarter. Section 3.1 discusses the details of this stage.

Once the agents settle the bargaining, H combines the two inputs $h_j(i)$ and $m_j(i)$ into final output $x_j(i)$ using Cobb-Douglas technology with its productivity θ. The production function is

$$x_j(i) = \theta \left[\frac{h_j(i)}{\eta_j}\right]^{\eta_j} \left[\frac{m_j(i)}{1-\eta_j}\right]^{1-\eta_j}, \tag{5}$$

where $0 < \eta_j < 1$ denotes the headquarter intensity in sector j.

The model is solved by backward induction. Section 3 focuses on a given active firm and derives conditions that determine technology l and organizational form k of this firm, referred to as its *structure* l-k. Section 4 moves the analysis to the sector level and considers firm entry/exit as well as the equilibrium prevalence of organizational forms, depending on sectoral characteristics.

3. Optimal Firm-Level Choices

Sectors differ by their headquarter intensity η_j, their cost advantage of unethical production captured by ν_j^u and by their distribution of firm productivities $G_j(\theta)$. Moreover, the interplay of these parameters will affect the equilibrium index of aggregate consumption X_j. However, the analysis in this section focuses on a single firm producing variety i that is active in a given sector. This firm is endowed with some productivity θ and faces a fixed index of aggregate consumption. To keep the notation concise, the following analysis will therefore drop the sector index j. When section 4 moves on to analyze sectoral differences, sectors will be distinguished by their headquarter intensity, cost advantage of unethical production or productivity dispersion.

3.1. Bargaining and Revenue Shares

Denote total expected revenue of the headquarter–supplier match producing variety i with structure l-k as $\mathrm{E}[R(i)_k^l]$. Noting that the firm faces no consumer boycott ($\mathbb{I}(i) = 1$) with

probability γ_k^l and faces zero demand ($\mathbb{I}(i) = 0$) otherwise, it follows from equations (3) and (5) that total expected revenue of the match are

$$\mathrm{E}[R(i)_k^l] = \gamma_k^l \; X^{\mu-\alpha} \; \theta^{\alpha} \left[\frac{h(i)_k^l}{\eta}\right]^{\alpha\eta} \left[\frac{m(i)_k^l}{1-\eta}\right]^{\alpha(1-\eta)}. \tag{6}$$

Due to contractual incompleteness and the relationship-specificity of both parties' inputs, H and M are facing a two-sided holdup problem once investments are sunk: M can sell its manufacturing input only to H and the headquarter cannot produce final output without the supplier's input. Therefore, the two agents bargain over the surplus from the relationship. The bargaining between H and M is modeled as a generalized Nash bargaining game, where each party receives its outside option plus a share of the ex post gains. Denote the share of surplus the headquarter receives as $\beta \in (0, 1)$ and the supplier's share as $1 - \beta$.

While the share β is exogenous, the share of expected revenue each party receives (β_k for H and $1 - \beta_k$ for M) depend on the agents' outside options and are therefore endogenous: With vertical integration, the headquarter owns residual rights of control over the manufacturing input and can seize it in case the bargaining fails. However, this is assumed to lead to efficiency losses, which is why H can recover only a fraction δ of final output, which translates into revenue of $\delta^{\alpha}\ \mathrm{E}[R(i)_k^l]$. As the supplier's outside option is 0, this leaves ex post gains of $(1 - \delta^{\alpha})\ \mathrm{E}[R(i)_k^l]$, which implies $\beta_V = \delta^{\alpha} + \beta(1 - \delta^{\alpha})$. Under outsourcing on the other hand, both parties have an outside option of 0, hence $\beta_O = \beta$.

Due to the fact that the allocation of property rights affects the allocation of expected revenue, the choice of organizational form influences the incentives to invest for both parties. Specifically, integration increases the headquarter's share of expected revenue ($\beta_V > \beta_O$) and therefore alleviates underinvestment by H. On the other hand, outsourcing incentivizes the supplier to increase its investments.

3.2. Noncooperative Investments and Profits

Both inputs are produced using only labor. Production of 1 unit of $h(i)$ requires 1 unit of northern labor, i.e., occurs at marginal costs of w^N. Production of 1 unit of $m(i)$ requires ν^l units of southern labor, so marginal costs are $\nu^l\, w^S$. Therefore, expected operating profits of H and M are

$$\mathrm{E}\left[\pi(i)_{Hk}^l\right] = \beta_k\ \mathrm{E}[R(i)_k^l] - w^N\ h(i)_k^l + t - w^N\, f_{Hk} \tag{7}$$

$$\text{and} \qquad \mathrm{E}\left[\pi(i)_{Mk}^l\right] = (1 - \beta_k)\ \mathrm{E}[R(i)_k^l] - \nu^l\, w^S\ m(i)_k^l - t - w^N\, f_{Mk}, \tag{8}$$

where $t \lesseqgtr 0$ is the up-front participation fee to be paid by M and f_{Hk} (f_{Mk}) is the components of the fixed costs $f_k \equiv f_{Hk} + f_{Mk}$ that H (M) has to bear.

Due to contractual incompleteness, H and M choose their investments noncooperatively: both maximize only their private variable profits, which consist of on their own share of expected revenue minus their marginal costs. Specifically, their respective maximization problems are

$$h(i)_k^l = \underset{h(i)_k^l}{\arg\max} \quad \beta_k \ \mathrm{E}[R(i)_k^l] - w^N \ h(i)_k^l \tag{9}$$

$$\text{and} \qquad m(i)_k^l = \underset{m(i)_k^l}{\arg\max} \ (1-\beta_k) \ \mathrm{E}[R(i)_k^l] - \nu^l \, w^S \ m(i)_k^l. \tag{10}$$

Maximization leads to the following mutually optimal investment quantities (see appendix B.1):

$$h(i)_k^l = (X^{\mu-\alpha}\,\theta^\alpha)^{\frac{1}{1-\alpha}} \ \alpha \ \frac{\eta\,\beta_k}{w^N} \ \frac{\psi_k^l}{\mathcal{C}_k}, \tag{11}$$

$$m(i)_k^l = (X^{\mu-\alpha}\,\theta^\alpha)^{\frac{1}{1-\alpha}} \ \alpha \ \frac{(1-\eta)\,(1-\beta_k)}{\nu^l\, w^S} \ \frac{\psi_k^l}{\mathcal{C}_k}, \tag{12}$$

$$\text{where} \qquad \psi_k^l \equiv \left[\frac{\alpha \ (\gamma_k^l)^{\frac{1}{\alpha}}}{(w^N)^\eta \ (\nu^l \, w^S)^{1-\eta}} \ \phi_k \right]^{\frac{\alpha}{1-\alpha}}, \tag{13}$$

$\phi_k \equiv \mathcal{C}_k^{\frac{1-\alpha}{\alpha}} \ \beta_k^\eta \ (1-\beta_k)^{1-\eta}$ and $\mathcal{C}_k \equiv 1 - \alpha\,[\beta_k \eta + (1-\beta_k)(1-\eta)]$.

Using investments from equations (11) and (12), equation (6) implies that expected revenue is given by

$$\mathrm{E}[R(i)_k^l] = (X^{\mu-\alpha}\,\theta^\alpha)^{\frac{1}{1-\alpha}} \ \frac{\psi_k^l}{\mathcal{C}_k}. \tag{14}$$

Therefore, by equations (7) and (8), expected operating profits of headquarter and supplier are

$$\mathrm{E}\,[\pi(i)_{Hk}^l] = (X^{\mu-\alpha}\,\theta^\alpha)^{\frac{1}{1-\alpha}} \ \beta_k \ [1 - \alpha\,\eta] \ \frac{\psi_k^l}{\mathcal{C}_k} + t - w^N \, f_{Hk} \tag{15}$$

$$\text{and} \qquad \mathrm{E}\,[\pi(i)_{Mk}^l] = (X^{\mu-\alpha}\,\theta^\alpha)^{\frac{1}{1-\alpha}} \ (1-\beta_k) \ [1 - \alpha\,(1-\eta)] \ \frac{\psi_k^l}{\mathcal{C}_k} - t - w^N \, f_{Mk}. \tag{16}$$

The up-front participation fee t is set by the headquarter when initiating a contract with M. As M competes with an unbounded pool of alternative suppliers, H has an incentive to raise t until the supplier's participation constraint binds, such that the equilibrium transfer payment satisfies $\mathrm{E}\,[\pi(i)_{Mk}^l] = 0$.[7] Therefore, H absorbs total expected profits

[7] As t is defined such that $\mathrm{E}\,[\pi(i)_{Mk}^l] = 0$, the equilibrium transfer payment determined by the headquarter depends on the choice of technology and the anticipated choice of technology. However, as headquarter and supplier determine the (non-negotiable) transfer payment immediately upon forming a match, it is sunk and its level plays no role for any further decisions to be made. Therefore, for notational convenience, the transfer payment is denoted simply as t.

of the match, $\mathrm{E}\left[\pi(i)_k^l\right] = \mathrm{E}[R(i)_k^l] - w^N\ h(i)_k^l - \nu^l\, w^S\ m(i)_k^l - w^N\, f_k$. By equations (11), (12) and (14) this amounts to total expected profits of

$$\mathrm{E}\left[\pi(i)_k^l\right] = (X^{\mu-\alpha}\,\theta^{\alpha})^{\frac{1}{1-\alpha}}\ \psi_k^l - w^N\, f_k. \tag{17}$$

Equations (16) and (17) are essential for the key decisions in the model: $\mathrm{E}\left[\pi(i)_{Mk}^l\right]$ is what the supplier considers when choosing between ethical and unethical technology; total expected profits of the match, $\mathrm{E}\left[\pi(i)_k^l\right]$, govern the headquarter's choice of organizational form (as well as its exit decision). Note how variable expected profits in equation (17) are determined by ψ_k^l (defined in equation (13)), scaled by the firm's productivity and the aggregate consumption index. The term ψ_k^l in turn has three key determinants: the boycott risk, captured by γ_k^l, the cost advantage of unethical production ν^l and ϕ_k. While the first two are only relevant in case of unethical production, ϕ_k captures the traditional underinvestment problem as in Antràs (2003) and Antràs & Helpman (2004), which leads to the *Antràs mechanism* for the choice of organizational form: increasing the headquarter's share of revenue increases profits for high headquarter intensities but decreases profits in components intensive sectors, depending on the severity of each party's underinvestment.[8] As ψ_k^l captures all determinants of expected variable profits that are sensitive to the endogenous choices of H and M, it will henceforth be referred to as the *adjustable profits* term. Note that the firm cannot freely choose adjustable profits – it is H's choice of organizational form k and M's choice of technology l that assign one of the four sectoral levels $\psi_V^e, \psi_V^u, \psi_O^e$ or ψ_O^u to the firm. Together with the firm's productivity θ and the consumption index X (both of which are exogenous to the firm), adjustable profits determine the overall level of expected variable profits.

Equations (13) and (17) make evident the ramifications of the choice of technology and the choice of organizational form. Unethical production on the one hand entails a boycott risk but on the other gives access to lower marginal costs (see section 3.3). The choice of organizational form always affects fixed costs and the Antràs mechanism captured in ϕ_k. Moreover, integration increases the boycott risk for strictly unethical firms – but decreases the boycott risk if the supplier is only unethical under outsourcing. In the latter case however, integration also nullifies the unethical cost advantage. These multiple trade-offs will be discussed in section 4.1.

3.3. Technology Choice

After H has chosen organizational form $k \in \{V, O\}$ (integration or outsourcing), M chooses to employ technology $l \in \{e, u\}$, i.e., the ethical or unethical technology. The

[8] The term ϕ_k is structurally identical to $\phi(\zeta, \eta)$ from Antràs & Helpman (2004, p. 568): $\frac{\partial \phi}{\partial \beta_k} > 0$ for large η, whereas $\frac{\partial \phi}{\partial \beta_k} < 0$ for low η (see Antràs & Helpman 2004, fn. 6).

supplier prefers unethical technology if $\mathrm{E}\left(\pi(i)^u_{Mk}\right) > \mathrm{E}\left(\pi(i)^e_{Mk}\right)$. While using the unethical technology offers a cost advantage due to lower marginal costs ($\nu^u < \nu^e = 1$), it entails the risk of being hit by a consumer boycott ($\gamma^u_k < \gamma^e_k = 1$). This trade-off – which is also apparent from inspection of adjustable profits in equation (13) – implies that the unethical technology is attractive if the cost advantage is strong (low ν^u) or if the risk of being subject to a boycott for unethical firms is low (high γ^u_k). Specifically, the supplier is indifferent between both technologies if the sectoral cost advantage of unethical production is given by

$$\tilde{\nu}_k \equiv (\gamma^u_k)^{\frac{1}{\alpha(1-\eta)}}. \tag{18}$$

The following proposition summarizes the choice of technology:

Proposition 1 (Choice of Technology)**.** *The strongest cost advantage of unethical production (i.e., the lowest ν^u) for which M chooses ethical technology under organizational form k is given by the technology cutoff $\tilde{\nu}_k$ from equation (18) and $\tilde{\nu}_V < \tilde{\nu}_O$. M produces unethically for any $\nu^u < \tilde{\nu}_k$. In some sectors, the choice of technology depends on the organizational form k whereas it is independent of k in other sectors:*

- *If $\nu^u < \tilde{\nu}_V$, M is unethical independently of k. Denote sectors where this is the case as "u,u sectors".*
- *If $\tilde{\nu}_V \leq \nu^u < \tilde{\nu}_O$, M is ethical under integration but unethical under outsourcing. Denote sectors where this is the case as "e,u sectors".*
- *If $\tilde{\nu}_O \leq \nu^u$, M is ethical independently of k. Denote sectors where this is the case as "e,e sectors".*

Proof. See appendix A.1.

Proposition 1 points out that the choice of technology – conditional on the choice of organizational form – depends only on sectoral variables (the cost advantage of unethical production and the *technology cutoff* from equation (18)). It is, however, independent of the firm's productivity draw θ. Therefore, in any given sector, all firms that exhibit the same organizational form will also employ the same technology. This allows to establish the typology of u,u, e,u and e,e sectors, referring to the choice of technology under integration (denoted by the first letter) and outsourcing (denoted by the second letter).

Figure 1 illustrates how different levels of the cost advantage of unethical production give rise to the three types of sectors from proposition 1. The figure shows the inverse of the technology cutoff (equation (18)) and should therefore be interpreted as follows: For a given no-boycott probability (γ^u_k; on the vertical axis), the corresponding value of ν^u on the horizontal axis is the strongest cost advantage (lowest ν^u) such that M prefers ethical

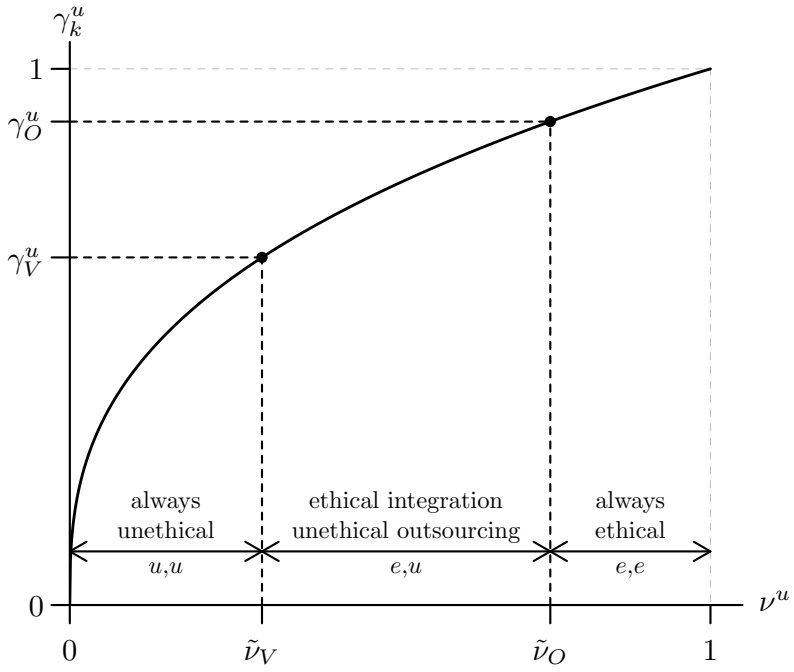

Figure 1: Choice of technology. For a given no-boycott probability (γ_k^u on the vertical axis), the corresponding value of ν^u on the horizontal axis is the strongest cost advantage (lowest ν^u) such that M prefers ethical production. If ν^u is below $\tilde{\nu}_k$, the supplier chooses the unethical technology.

production. The two exogenous no-boycott probabilities γ_V^u and γ_O^u therefore define the technology cutoffs $\tilde{\nu}_V$ and $\tilde{\nu}_O$. Which of these two cutoffs is relevant for a given supplier depends on the organizational form chosen by H. A supplier produces unethically if ν^u in its sector is below the relevant cutoff, i.e., if the cost advantage is strong enough (low ν^u) to outweigh the boycott risk. If ν^u is below both cutoffs, then the cost advantage of unethical production is so strong that M is unethical regardless of the organizational form – this is the case in u,u sectors. Conversely, in e,e sectors the cost advantage of unethical production is so weak (ν^u is above both cutoffs) that the supplier produces ethically, independently of the organizational form. If the cost advantage is between the two cutoffs, the supplier is ethical under integration but unethical under outsourcing (e,u sectors).

The technology cutoff depends on the no-boycott probability, the measure of substitutability across varieties (α) as well as the headquarter intensity (η). Firstly, the no-boycott probability under unethical production, γ_k^u, is at the core of the trade-off between boycott risk and cost savings outlined above. In terms of comparative statics, $\frac{\partial \tilde{\nu}_k}{\partial \gamma_k^u} > 0$ and as outsourcing increases the no-boycott probability ($\gamma_V^u < \gamma_O^u$), it follows that $\tilde{\nu}_V < \tilde{\nu}_O$: a weaker cost advantage is sufficient to induce unethical production under outsourcing. Hence, increased deniability under outsourcing makes unethical production

more attractive and can serve as a substitute for a lower cost advantage of unethical production. Secondly, higher headquarter intensity η decreases $\tilde{\nu}_k$ ($\frac{\partial \tilde{\nu}_k}{\partial \eta} < 0$). Therefore, a stronger cost advantage is required to induce unethical production in headquarter intensive sectors. With higher headquarter intensity, the investment level of M is relatively low and therefore a given level of per-unit cost savings from unethical production leads to lower overall cost savings, which may not be worth the risk of attracting a boycott. Finally, higher substitutability and hence lower mark-ups increases the technology cutoff ($\frac{\partial \tilde{\nu}_k}{\partial \alpha} > 0$): With lower mark-ups, less revenue is at stake in case of a boycott, making the unethical technology beneficial even at weaker cost advantages. In figure 1, higher headquarter intensity would make the graph steeper, whereas it becomes flatter for higher values of α.

3.4. Choice of Organizational Form

According to proposition 1, the type of technology M is going to use may depend on (e,u sectors) or be independent of (e,e and u,u sectors) the organizational form. When choosing organizational form $k \in \{V, O\}$ (integration or outsourcing), H anticipates and takes into account how this will affect M's technology choice. To capture this notationally, denote the anticipated technology choices of the supplier under integration and outsourcing as l_V and l_O, respectively. As technology choice depends only on organizational form and exogenous sectoral variables, the sector type (u,u, e,u, or e,e) determines l_V and l_O.

The firm prefers integration if this increases expected profits of the match, i.e., if $\mathrm{E}(\pi(i)_V^{l_V}) > \mathrm{E}(\pi(i)_O^{l_O})$ (see equation (17)). This implies for the choice of organizational form:

Proposition 2 (Choice of Organizational Form)**.** *The integration cutoff productivity is*

$$\tilde{\theta}^{l_V,l_O} \equiv X^{\frac{\alpha-\mu}{\alpha}} \left[w^N \frac{f_V - f_O}{\psi_V^{l_V} - \psi_O^{l_O}} \right]^{\frac{1-\alpha}{\alpha}}. \tag{19}$$

The firm prefers organizational form k, which is determined as follows:

$$k = \begin{cases} V & \text{(integration)} \quad \text{if} \quad \theta > \tilde{\theta}^{l_V,l_O} \ \wedge \ \psi_V^{l_V} > \psi_O^{l_O}; \\ O & \text{(outsourcing)} \quad \text{otherwise.} \end{cases}$$

Proof. See appendix A.2.

With the choice of organizational form, H simultaneously decides on adjustable profits, $\psi_k^{l_k}$, and fixed costs of organizing production, $w^N f_k$. Considering only fixed costs, outsourcing would always be preferable because $f_V > f_O$. This makes adjustable profits $\psi_k^{l_k}$ crucial for the choice of organizational form: Only if integration offers higher adjustable profits than outsourcing ($\psi_V^{l_V} > \psi_O^{l_O}$), there is scope for offsetting the increase in fixed costs. Then, it depends on the firm's productivity θ whether integration is actually preferred:

Both, adjustable profits as well as productivity, act as multiplicative factors in the firm's variable profits (see equation (17)). If $\psi_V^{l_V} > \psi_O^{l_O}$, the firm's productivity θ must be sufficiently large ($\theta > \tilde{\theta}^{l_V,l_O}$) in order to increase variable profits by more than fixed costs decrease total profits – only then integration is preferred. On the other hand, if $\psi_V^{l_V} < \psi_O^{l_O}$, there is no trade-off to be considered because outsourcing in strictly preferred, both in terms of adjustable profits as well as fixed costs.

The discussion thus far has excluded two important issues: Firstly, proposition 2 only concerns the question whether a given firm in a given sector prefers integration or outsourcing. In both cases, however, even the optimal organizational form may still lead to negative operating profits, causing the firm to exit the market. Secondly, it still needs to be discussed what underlying mechanisms determine adjustable profits ψ_k^l and hence the integration choice as well as – indirectly – the technology choice. Section 4 will address both of these issues, thereby setting the stage for an analysis of the share of firms with organizational form k and technology l in a given sector (in section 4.4).

4. Analysis of the Sector-Level Equilibrium

This section moves the focus of the analysis to the sector level. Recall that sectors exhibit different cost advantages of unethical production, which assigns them to one of the three sector types established in proposition 1. Sectors are also heterogeneous with respect to their headquarter intensity, which first and foremost determines strength and direction of the Antràs mechanism. Section 4.1 explores how the Antràs mechanism interacts with other mechanisms that incentivize the headquarter's integration decision. Finally, sectors also differ with respect to their productivity dispersion, which affects entry (section 4.3) as well as the prevalence of organizational forms (section 4.4).

4.1. Sectoral Incentives for Integration – Three Mechanisms

As outlined in the discussion of proposition 2, firms in a given sector only consider integration if this offers higher adjustable profits than outsourcing ($\psi_V^{l_V} > \psi_O^{l_O}$). Even if that is the case, a given firm does not necessarily prefer integration over outsourcing due to the higher fixed costs of the former, which need to be offset by a sufficiently strong increase of variable profits $(X^{\mu-\alpha}\,\theta^{\alpha})^{\frac{1}{1-\alpha}}\,\psi_k^l$ through adjustable profits (ψ_k^l) – which is the case for firms with sufficiently high productivity. Therefore, integration in a given sector is a *possible* equilibrium outcome (and implemented by sufficiently productive firms) if it offers higher adjustable profits than outsourcing ($\psi_V^{l_V} > \psi_O^{l_O}$), whereas integration is ruled out a priori and all active firms will outsource in sectors with $\psi_V^{l_V} < \psi_O^{l_O}$.[9]

[9] In the remainder of the paper, integration being "possible" always refers to the situation that integration is a possible equilibrium outcome (because $\psi_V^{l_V} > \psi_O^{l_O}$), which is chosen by high-productivity firms. If $\psi_V^{l_V} < \psi_O^{l_O}$, firms still have the option to integrate their suppliers, but no firms will do so because this leads to lower profits (due to higher fixed costs and lower adjustable profits; see section 3.4).

This section analyzes which underlying mechanisms determine how the organizational form affects adjustable profits $\psi_k^{l_k}$. Depending on the sector type, three different comparisons need to be made: ψ_V^e vs. ψ_O^e in e,e sectors; ψ_V^e vs. ψ_O^u in e,u sectors; and ψ_V^u vs. ψ_O^u in u,u sectors. Before turning to these comparisons one by one, consider the adjustable profits term in equation (13) and how the firm structure affects its components: the choice of organizational form affects ϕ_k and γ_k^l (through the Antràs mechanism and deniability, respectively); the type of technology determines γ_k^l and ν^l (through the boycott risk and the cost advantage of unethical production, respectively). For the following analysis, it will sometimes be convenient to consider the ratio $\psi_V^{l_V}/\psi_O^{l_O}$ rather than the inequality $\psi_V^{l_V} > \psi_O^{l_O}$: In the ratio, all common terms of the two adjustable profits terms cancel and integration is possible if the fraction is larger than 1.

In e,e sectors, the firm chooses between structure e-V and e-O because M will produce ethically with certainty. Therefore, neither the boycott risk nor the cost advantage of unethical production plays a role for the question whether integration is possible, i.e., if $\frac{\psi_V^e}{\psi_O^e}$ is larger than 1. Only ϕ_k drives the change in ψ_k^e, reflecting the Antràs mechanism for the choice of organizational form: by increasing the share of revenue H receives, integration alleviates underinvestment by H but makes underinvestment by M more severe. Whether this increases or decreases ϕ_k (and hence ψ_k^e) depends on the headquarter intensity of the sector: increasing the headquarter's share of revenue (integration) increases adjustable profits for high headquarter intensities (η) but decreases adjustable profits in components-intensive sectors. Therefore, the Antràs mechanism may call for integration (high η) or outsourcing (low η). In e,e sectors, integration is only possible ($\frac{\psi_V^e}{\psi_O^e} > 1$) if it is incentivized by the Antràs mechanism, which is the case when $\bar{\phi} \equiv \frac{\phi_V}{\phi_O} > 1$. Only then adjustable profits are higher under integration than under outsourcing ($\psi_V^e > \psi_O^e$).

In e,u sectors, the firm chooses between structure e-V and u-O because M will produce ethically under integration but unethically under outsourcing. As in e,e sectors, the Antràs mechanism is active and incentivizes integration if $\bar{\phi} > 1$ and outsourcing otherwise. However, in e,u sectors ϕ_k is not the only element of adjustable profits and therefore of the ratio $\frac{\psi_V^e}{\psi_O^u}$ that responds to the choice of organizational form: While integration leads to ethical production ($\nu^e = 1$) and a no-boycott probability of $\gamma_V^e = 1$, outsourcing entails unethical cost savings ($\nu^u < 1$) but a boycott risk ($\gamma_O^u < 1$). This trade-off will be referred to as the *unethical mechanism*.[10] Ceteris paribus – keeping ϕ_k fixed to focus only on the unethical mechanism – this mechanism incentivizes integration (i.e., leads to larger adjustable profits in structure e-V as compared to structure u-O) if $\frac{(\gamma_O^u)^{1/\alpha}}{(\nu^u)^{1-\eta}} < 1$ and fosters outsourcing if

[10] The trade-off behind the unethical mechanism shares strong similarities to the trade-off governing the choice of technology. For the technology choice, M weights the decrease of the no-boycott risk (depending on k: γ_V^u or γ_O^u vs. no risk) against the cost advantage of unethical production and considers the impact on its private profits. The unethical mechanism reflects the headquarter's counterpart to this decision: H weights the decrease of the no-boycott risk under outsourcing (γ_O^u vs. no risk) against the cost advantage of unethical production and considers the impact on total profits of the match.

that fraction is larger than 1. However, by the definition of e,u sectors (see proposition 1), in these sectors it is always the case that $\nu^u < \tilde{\nu}_O$, which implies $\frac{(\gamma_O^u)^{1/\alpha}}{(\nu^u)^{1-\eta}} > 1$. Therefore, in these sectors the unethical mechanism *always* incentivizes outsourcing because the cost advantage of unethical production always outweighs the boycott risk. Overall, integration in e,u sectors is only possible ($\psi_V^e > \psi_O^u$) if the Antràs mechanism supports integration and if this effect is stronger than the push for outsourcing by the unethical mechanism. If even the Antràs mechanism incentivizes outsourcing, integration is ruled out because then $\psi_V^e < \psi_O^u$.

In u,u sectors, the firm chooses between structure u-V and u-O because M will produce unethically with certainty. Again, the Antràs mechanism fosters integration if $\bar{\phi} > 1$ and outsourcing otherwise. In addition, the ratio $\frac{\psi_V^u}{\psi_O^u}$ is affected by the *deniability mechanism* in u,u sectors: Reflecting the firm's lower credibility when denying knowledge of and responsibility for the technology used by an integrated unethical supplier, the no-boycott probability is lower under integration ($\gamma_V^u < \gamma_O^u$). The deniability mechanism captures the influence of this difference in boycott risks on the ratio $\frac{\psi_V^u}{\psi_O^u}$: The mechanism makes the ratio smaller, which means that in u,u sectors the deniability mechanism incentivizes outsourcing. Consequently, integration in u,u sectors is only possible ($\psi_V^u > \psi_O^u$) if the Antràs mechanism calls for integration and if this effect on adjustable profits is stronger than the incentive for outsourcing by the deniability mechanism. Otherwise, only outsourcing is possible ($\psi_V^u < \psi_O^u$).

As unethical mechanism and deniability mechanism are both related to the no-boycott probability under outsourcing γ_O^u, they are closely linked to each other. Yet, there are stark conceptual differences: For the unethical mechanism, the level of γ_O^u matters, which is traded-off against the cost savings of unethical production in e,u sectors. For the deniability mechanism, the level of γ_O^u also plays a role, but only to the extent that it affects the difference between γ_O^u and γ_V^u (which is what makes the deniability mechanism foster outsourcing). This is also why the deniability mechanism is inactive in e,u sectors: When integrated suppliers produce ethically, the boycott risk under integration (or the difference between γ_O^u and γ_V^u) plays no role. By the same token, in u,u sectors the unethical mechanism is inactive, because the supplier produces unethically in any case and therefore only the change of the boycott risk needs to be considered by the headquarter, not how the choice of organizational form could possibly affect cost savings of unethical production.

Summarizing the above insights on all three sector types, a clear pattern arises: Integration is generally only possible if the Antràs mechanism incentivizes integration. If additionally the unethical mechanism or the deniability mechanism are active (each supporting outsourcing), the Antràs mechanism needs to dominate that countervailing effect in order to enable integration. Therefore, the direction and strength of the effect that the Antràs mechanism has on adjustable profits, reflected in $\bar{\phi}$, determines whether

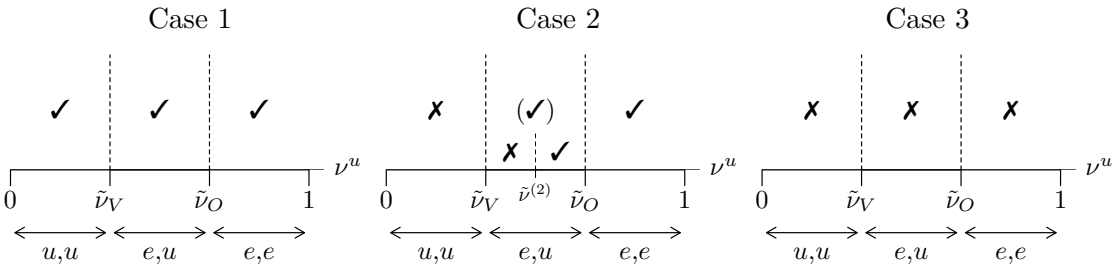

Figure 2: Illustration of the three cases from proposition 3. Case 1 represents the highest headquarter intensity (such that $(\gamma_O^u/\gamma_V^u)^{1/\alpha} < \bar{\phi}$); Case 3 represents the lowest headquarter intensity (such that $\bar{\phi} \leq 1$). In each panel, the cost advantage of unethical production becomes weaker from left to right, covering sectors of type u,u, e,u and e,e. A check mark indicates that this combination of sector type and headquarter intensity makes integration possible ($\psi_V^{l_V} > \psi_O^{l_O}$), whereas a cross symbol is used otherwise. In Case 2, integration is not possible in all e,u sectors, but only if $\nu^u > \tilde{\nu}^{(2)} \equiv \bar{\phi}^{\frac{1}{\eta-1}} \tilde{\nu}_O$.

integration is possible for all sectors depending on their respective sector types (i.e., whether $\psi_V^{l_V} > \psi_O^{l_O}$ for sectors with different levels of ν^u):

Proposition 3 (Possibility of Integration)**.** *Integration can be possible in all sector types, only in sectors with sufficiently weak cost advantages of unethical production or in no sector types:*

- Case 1: $1 < \left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{1/\alpha} < \bar{\phi}$. *Integration is possible for any* $\nu^u \in (0,1)$ *(i.e., in all u,u, e,u and e,e sectors).*
- Case 2: $1 < \bar{\phi} \leq \left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{1/\alpha}$. *Integration is possible in e,u sectors with a cost advantage that is sufficiently weak such that* $\nu^u > \tilde{\nu}^{(2)} \equiv \bar{\phi}^{\frac{1}{\eta-1}} \tilde{\nu}_O$ *and is possible in all e,e sectors.*
- Case 3: $\bar{\phi} \leq 1 < \left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{1/\alpha}$. *Integration is not possible for any* $\nu^u \in (0,1)$ *(i.e., neither in u,u, e,u nor e,e sectors).*

Proof. See appendix A.3.

Figure 2 illustrates the three cases from proposition 3. The crucial object that distinguishes between Cases 1–3 from proposition 3 is $\bar{\phi} \equiv \frac{\phi_V}{\phi_O}$. Depending on the headquarter intensity of the sector, $\bar{\phi}$ can be larger or smaller than 1 (see footnote 8): Sectors with high headquarter intensity have a relatively high $\bar{\phi}$, captured by Case 1 of proposition 3. Then, the Antràs mechanism calls for integration and dominates the unethical mechanism (in e,u sectors) as well as the deniability mechanism (in u,u sectors). This applies for all headquarter intensities that are sufficiently large such that $\left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{1/\alpha} < \bar{\phi}$. Case 2 covers sectors where the headquarter intensity is lower – but still high enough for the Antràs

mechanism to incentivize integration ($1 < \bar{\phi}$). In this case, the deniability mechanism dominates the Antràs mechanism, ruling out integration as an equilibrium outcome in u,u sectors. In e,u sectors, the Antràs mechanism only dominates the unethical mechanism as long as $\nu^u > \tilde{\nu}^{(2)} \equiv \bar{\phi}^{\frac{1}{\eta-1}} \tilde{\nu}_O$; for all sectors with stronger cost advantages of unethical production, the unethical mechanism dominates and integration becomes unattractive.[11] Finally, if headquarter intensity drops enough to make $\bar{\phi} < 1$, even the Antràs mechanism fosters outsourcing, ruling out integration in all sector types. This is captured by Case 3 of proposition 3.

Taking into account the three cases from proposition 3 and the three sector types (u,u, e,u and e,e), in which scenarios is integration possible? Under Case 3, integration is disadvantageous in all sector types and all active firms will outsource. Under Case 2 in all u,u sectors and those e,u sectors where the cost advantage of unethical production is so strong that the unethical mechanism dominates the Antràs mechanism (i.e., sectors with $\nu^u \leq \tilde{\nu}^{(2)}$), all firms outsource as well. Conversely, Case 1 makes integration possible for all sector types and Case 2 allows integration in all e,e sectors as well as those e,u sectors where the cost advantage of unethical production is sufficiently weak such that the Antràs mechanism dominates ($\nu^u > \tilde{\nu}^{(2)}$). In these scenarios, a positive fraction of firms chooses integration. In order to analyze the prevalence of organizational forms in a given sectors, the latter cases where integration is chosen by a nonzero fraction of firms is arguably more interesting than the only outsourcing scenario. Therefore, the remainder of this paper will focus on scenarios where integration is possible (Case 1 for any sector type or Case 2 if $\nu^u > \tilde{\nu}^{(2)}$) but – for completeness – cover other scenarios as well.

4.2. Coexistence of Integration and Outsourcing

Proposition 2 states which firms prefer integration over outsourcing and section 4.1 discusses the mechanisms that determine whether a given sector permits integration as an equilibrium outcome at all. However, this does not consider which firms will prefer to *exit* instead of being active under any organizational form. Moreover, the possibility of exit (by low-productivity firms) implies that even sectors that allow integration may not permit a coexistence of both organizational forms – i.e., positive fractions of integrating *and* outsourcing firms – because all firms that prefer outsourcing over integration might actually exit. This calls for an analysis of possible profit orderings that takes into account the possibility of exit instead of integration or outsourcing.

Expected operating profits of the match are linear in $\theta^{\frac{\alpha}{1-\alpha}}$ (a transformation of the firm's productivity), as is evident from equation (17). Focusing first on the scenarios

[11] As $1 < \bar{\phi}$ in Case 2, $\tilde{\nu}^{(2)} \equiv \bar{\phi}^{\frac{1}{\eta-1}} \tilde{\nu}_O < \tilde{\nu}_O$. Therefore, the condition $\nu^u > \tilde{\nu}^{(2)}$ never rules out that integration occurs in at least some e,u sectors, because the interval $(\tilde{\nu}^{(2)}, \tilde{\nu}_O)$ will always have positive (nonzero) width.

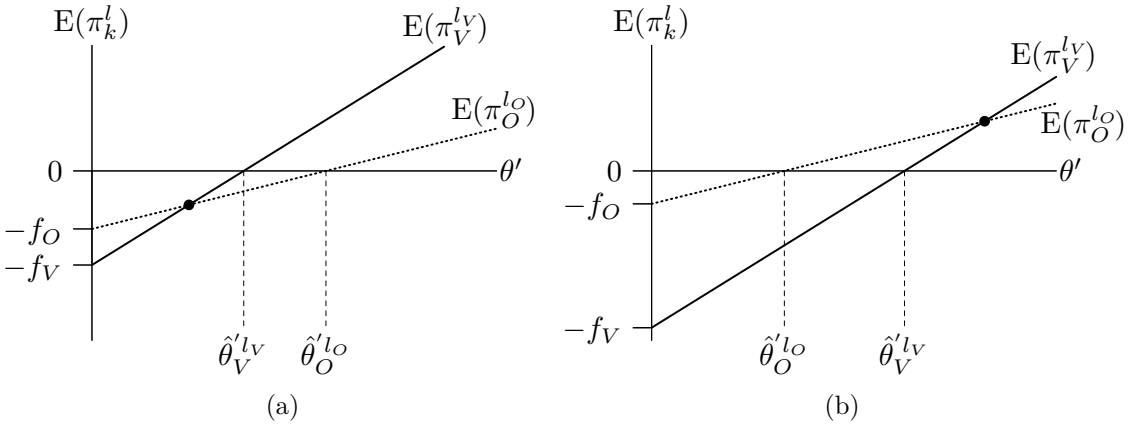

Figure 3: Profit orderings when integration is possible. The ordering in figure 3a supports only integration; figure 3b supports outsourcing (less productive firms) and integration (highly productive firms). A prime indicates that the respective object is transformed by raising it to the power $\frac{\alpha}{1-\alpha}$; e.g., the horizontal axis depicts $\theta^{\alpha/(1-\alpha)}$.

where integration is possible (Case 1 of proposition 3 for any sector type or Case 2 if $\nu^u > \tilde{\nu}^{(2)}$), the ranking of fixed costs ($f_V > f_O$) leaves room for two orderings of expected profits under integration and outsourcing, depicted in figure 3. The slopes of the profit lines in figure 3 are determined by adjustable profits ψ_k^l (and a transformation of the sector-specific consumption index). This means that whenever integration is possible (which requires higher adjustable profits under integration than under outsourcing), the profit line under integration will be steeper than the profit line under outsourcing (as in both panels of figure 3). Given their productivity draw θ, firms prefer the structure that corresponds to the higher profit line – but exit if even that structure leads to negative operating profits.

Figures 3a and 3b depict profit orderings for the same levels of adjustable profits but with different fixed costs. In figure 3a, where the ratio of fixed costs under integration vs. outsourcing is low, all firms that are too unproductive to integrate prefer exit over outsourcing. In figure 3b, where the fixed costs differential is high, the least productive firms exit, more productive firms outsource and the most productive firms integrate. The latter are firms with productivities to the right of the intersection of the two profit lines (indicated by a dot in figure 3); the corresponding integration cutoff productivity is $\tilde{\theta}^{l_V,l_O}$ from equation (19). So only the configuration in figure 3b supports outsourcing (less productive firms) and integration (highly productive firms) simultaneously. In contrast, in the configuration depicted in figure 3a, all active firms integrate.

To formalize the difference between the profit orderings in figures 3a and 3b, note that the profit orderings can be characterized by the ranking of minimum productivities to

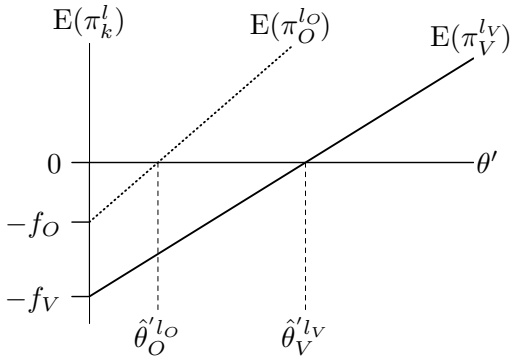

Figure 4: Profit ordering when only outsourcing is possible. If integration offers lower adjustable profits than outsourcing, integration is never optimal. A prime indicates that the respective object is transformed by raising it to the power $\frac{\alpha}{1-\alpha}$; e.g., the horizontal axis depicts $\theta^{\alpha/(1-\alpha)}$.

break even. Define $\hat{\theta}_k^l$ as the minimum productivity of a firm with structure k-l to yield zero expected operating profits. By $\mathrm{E}\left[\pi(i)_k^l(\hat{\theta}_k^l)\right] \equiv 0$, this minimum productivity equals

$$\hat{\theta}_k^l = X^{\frac{\alpha-\mu}{\alpha}} \left(\frac{w^N f_k}{\psi_k^l}\right)^{\frac{1-\alpha}{\alpha}}. \tag{20}$$

If $\hat{\theta}_V^{l_V} < \hat{\theta}_O^{l_O}$, all firms that do not exit – i.e., all active firms – integrate (as in figure 3a). Only if $\hat{\theta}_O^{l_O} < \hat{\theta}_V^{l_V}$ (and $\psi_V^{l_V} > \psi_O^{l_O}$ ensures that integration is possible), figure 3b arises. This condition implies:

$$\frac{f_O}{f_V} < \left[\left(\frac{\gamma_O^{l_O}}{\gamma_V^{l_V}}\right)^{\frac{1}{\alpha}} \left(\frac{\nu^{l_V}}{\nu^{l_O}}\right)^{1-\eta} \bar{\phi}^{-1}\right]^{\frac{\alpha}{1-\alpha}}. \tag{21}$$

To rule out that all firms that prefer outsourcing exit, fixed costs of outsourcing must be sufficiently low (keeping unproductive firms in the market) or fixed costs of integration must be sufficiently high (inducing outsourcing by medium-productive firms). Overall, this is not a very restrictive condition, as for any parameterization f_V can always be chosen large enough such that equation (21) holds.

Up to this point, the analysis in this section has focused on sectors where integration is possible. For sectors where integration is ruled out (Case 3 or Case 2 if $\nu^u \leq \tilde{\nu}^{(2)}$), the profit ordering is depicted in figure 4. The ranking of fixed costs ($f_V > f_O$) combined with adjustable profits (and therefore the slopes of the profit lines) under outsourcing being larger than under integration leaves only room for one profit ordering.

How are the three profit orderings from figures 3 and 4 related to the three cases of proposition 3? Under Case 1, two outcomes may arise: If the fixed costs constraint in equation (21) holds, the profit ordering in figure 3b occurs. Sectors under Case 1 with this

profit ordering constitute the *benchmark scenario*, which is characterized by a coexistence of integrating and outsourcing firms within the same sector. For sectors under Case 1 where the constraint in equation (21) is violated, the profit ordering in figure 3a arises, where all active firms integrate and which is consequently labeled the *only integration scenario*. Under Case 3, only the profit ordering from figure 4 is possible, where all active firms outsource and which is therefore referred to as the *only outsourcing scenario*. Under Case 2, one of the three aforementioned scenarios will apply: For sectors with a sufficiently strong cost advantage of unethical production ($\nu^u \leq \tilde{\nu}^{(2)}$), integration is ruled out such that these sectors fall under the only outsourcing scenario. For sectors with weaker cost advantages of unethical production ($\nu^u > \tilde{\nu}^{(2)}$), the situation is comparable to Case 1: If equation (21) holds, the sectors exhibit the same characteristics as under the benchmark scenario; otherwise the only integration scenario applies.

In summary, the benchmark scenario considers sectors (of any type u,u, e,u or e,e) with sufficiently high headquarter intensity such that they fall under Case 1 of proposition 3 and a sufficiently large fixed cost differential such that equation (21) holds (as depicted in figure 3b). This ensures that neither organizational form is dominated by the other (either because integration offers no advantage with regards to adjustable profits or because a too low fixed cost differential makes all non-integrating firms exit). In this benchmark scenario, firms with productivities below $\hat{\theta}_O^{l_O}$ exit; firms between $\hat{\theta}_O^{l_O}$ and $\tilde{\theta}^{l_V,l_O}$ outsource and firms above $\tilde{\theta}^{l_V,l_O}$ integrate. All other sectors are either captured by the only integration scenario or the only outsourcing scenario, with entry cutoffs given by $\hat{\theta}_V^{l_V}$ and $\hat{\theta}_O^{l_O}$, respectively.

Before turning to the prevalence of organizational forms in section 4.4, section 4.3 closes the model by analyzing firm entry and the equilibrium consumption index.

4.3. Closing the Model

Denote a firm's actual expected operating profits – conditional on the firm's productivity draw θ as well as the optimal choice of technology and organizational form according to propositions 1 and 2 – as $\pi(\theta, X)$:

$$\pi(\theta, X) \equiv \max_{k\in\{V,O\},\ l\in\{e,u\}} \mathrm{E}\left[\pi(i)_k^l\right]. \tag{22}$$

Conditional on the firm structure k-l, the only endogenous variable that actual expected operating profits depend on is the sectoral consumption index X (see equation (17)), which will be pinned down by the free entry condition as presented below.

Actual expected operating profits increase in θ and drop below zero if productivity is below some cutoff level $\bar{\theta}$. For $\theta < \bar{\theta}$, the firm exits the industry upon observing its productivity level. Therefore, free entry implies that the costs of entering the sector and

making a productivity draw need to be equal to expected profits (0 for $\theta < \bar{\theta}$ and $\pi(\theta, X)$ for $\bar{\theta} \leq \theta$):

$$\int_{\bar{\theta}}^{\infty} \pi(\theta, X)\, \mathrm{d}G(\theta) = w^N f_E. \tag{23}$$

Solving the free entry condition (23) yields a solution for the sectoral consumption index X. However, doing so requires to fully specify the scenario under consideration in order to evaluate $\pi(\theta, X)$ and to determine the entry cutoff $\bar{\theta}$. The following first considers the benchmark scenario outlined in section 4.2 to solve the free entry condition for the consumption index X, before also presenting the consumption indices for sectors in the only integration scenario as well as the only outsourcing scenario.

The equilibrium consumption index for the benchmark scenario is denoted as X^{l_V, l_O}, because it differs across sector types.[12] Recall that in the benchmark scenario, firms with $\theta < \hat{\theta}_O^{l_O}$ exit (therefore, $\bar{\theta} = \hat{\theta}_O^{l_O}$); firms with $\hat{\theta}_O^{l_O} \leq \theta \leq \tilde{\theta}^{l_V, l_O}$ outsource (with technology l_O); and firms with $\tilde{\theta}^{l_V, l_O} < \theta$ integrate (with technology l_V) – see figure 3b. In this scenario, the free entry condition can be written as:[13]

$$\int_{\hat{\theta}_O^{l_O}}^{\tilde{\theta}^{l_V, l_O}} \mathrm{E}\left[\pi(i)_O^{l_O}\right] \mathrm{d}G(\theta) + \int_{\tilde{\theta}^{l_V, l_O}}^{\infty} \mathrm{E}\left[\pi(i)_V^{l_V}\right] \mathrm{d}G(\theta) = w^N f_E. \tag{24}$$

Under the assumption that $\frac{\alpha}{1-\alpha} < z$, evaluating the free entry condition delivers the following solution for the consumption index in a sector of type l_V, l_O in the benchmark scenario:

$$X^{l_V, l_O} = \left[\frac{\mathcal{C}_X\, z b^z}{w^N f_E} \left[(\psi_V^{l_V} - \psi_O^{l_O}) \left(w^N \frac{f_V - f_O}{\psi_V^{l_V} - \psi_O^{l_O}} \right)^{\frac{\alpha - z(1-\alpha)}{\alpha}} + \psi_O^{l_O} \left(\frac{w^N f_O}{\psi_O^{l_O}} \right)^{\frac{\alpha - z(1-\alpha)}{\alpha}} \right] \right]^{\frac{\alpha}{z(\alpha-\mu)}}, \tag{25}$$

where $\mathcal{C}_X \equiv \frac{1}{z - \frac{\alpha}{1-\alpha}} - \frac{1}{z}$. See appendix B.2 for details.

In the only integration scenario, depicted in figure 3a, firms with productivities $\theta < \hat{\theta}_V^{l_V}$ exit (therefore, $\bar{\theta} = \hat{\theta}_V^{l_V}$) and all remaining firms integrate with technology l_V. In the only outsourcing scenario (see figure 4), firms with productivities $\theta < \hat{\theta}_O^{l_O}$ exit (therefore, $\bar{\theta} = \hat{\theta}_O^{l_O}$) and all active firms outsource with technology l_O. For both scenarios, the free entry condition can be expressed as $\int_{\hat{\theta}_k^{l_k}}^{\infty} \mathrm{E}\left[\pi(i)_k^{l_k}\right] \mathrm{d}G(\theta) = w^N f_E$, with $k = V$ for the only integration scenario and $k = O$ for the only outsourcing scenario. Solving for the

[12] Hence, technically, all expressions that involve the consumption index should be written with l_V, l_O indices. E.g., equation (17) should be $\mathrm{E}\left[\pi(i)_k^{l_V, l_O}\right] = ((X^{l_V, l_O})^{\mu-\alpha}\, \theta^{\alpha})^{\frac{1}{1-\alpha}}\ \psi_k^{l_k} - w^N f_k$. However, for expositional clarity, these additional indices have been omitted throughout the paper.

[13] This assumes that $\hat{\theta}_O^{l_O}$ is not smaller than the minimum productivity b from equation (4). The same applies to the discussion in section 4.2. As b must only be larger than zero, b can always be chosen sufficiently small to satisfy these constraints.

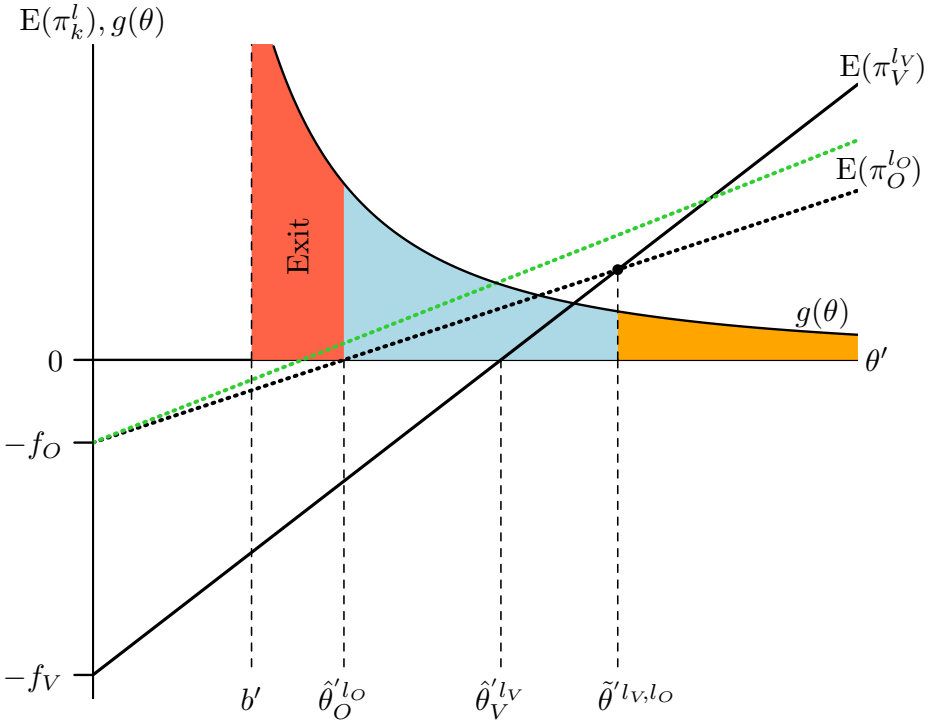

Figure 5: Productivity and firm choices in a l_V, l_O sector. The curve $g(\theta)$ is the density function of firm productivities (with minimum productivity b). A prime indicates that the respective object is transformed by raising it to the power $\frac{\alpha}{1-\alpha}$; e.g., the horizontal axis depicts $\theta^{\alpha/(1-\alpha)}$. The blue (orange) area is proportional to the sectoral share of entrants that choose outsourcing (integration). As some firms exit (red area), the share $\sigma_O^{l_V,l_O}$ ($\sigma_V^{l_V,l_O}$) of *active* firms that choose outsourcing (integration) is reflected by the blue (orange) area divided by the sum of the blue and orange area. The green dotted line depicts profits of an outsourcing firm with higher adjustable profits as compared to the baseline (black dotted line).

equilibrium consumption index yields X^{l_V} and X^{l_O} (for the only integration scenario and the only outsourcing scenario, respectively):

$$X^{l_k} = \left[\frac{\mathcal{C}_X\, z b^z}{w^N\, f_E}\, \psi_k^{l_k} \left(\frac{w^N\, f_k}{\psi_k^{l_k}}\right)^{\frac{\alpha - z(1-\alpha)}{\alpha}}\right]^{\frac{\alpha}{z(\alpha-\mu)}}. \tag{26}$$

4.4. Prevalence of Organizational Forms

This section analyzes the prevalence of organizational forms, i.e., the shares of firms in a given sector that integrate or outsource. Denote the fraction of active firms that choose structure k-l_k (in a l_V, l_O sector) as $\sigma_k^{l_V,l_O}$. Under the only integration scenario or the only outsourcing scenario, these fractions are trivially 0 and 1, respectively. Therefore, the

following analysis focuses on the benchmark scenario, where integrating and outsourcing firms coexist within a given sector.

Recall that in the benchmark scenario, the least productive firms will exit, firms with $\hat{\theta}_O^{l_O} \leq \theta \leq \tilde{\theta}^{l_V,l_O}$ will outsource and firms with $\tilde{\theta}^{l_V,l_O} < \theta$ integrate (see figure 3b). Hence, the share of active firms in a given sector that integrate their suppliers is

$$\sigma_V^{l_V,l_O} = \frac{1 - G(\tilde{\theta}^{l_V,l_O})}{1 - G(\hat{\theta}_O^{l_O})} \tag{27}$$

and the remaining active firms outsource their suppliers: $\sigma_O^{l_V,l_O} = 1 - \sigma_V^{l_V,l_O}$. Figure 5 (black lines) illustrates how these firm shares are linked to firm choices depending on productivity levels and the distribution of productivities within a sector. Evaluating equation (27) gives the equilibrium share of active firms that choose integration in a l_V, l_O sector (in the benchmark scenario):

$$\sigma_V^{l_V,l_O} = \left(\frac{\psi_V^{l_V} - \psi_O^{l_O}}{\psi_O^{l_O}} \frac{f_O}{f_V - f_O} \right)^{z \frac{1-\alpha}{\alpha}}. \tag{28}$$

The following proposition summarizes the determinants of the share of integrating firms:[14]

Proposition 4 (Prevalence of Organizational Forms)**.** *In the benchmark scenario, the equilibrium share of active firms that choose integration in a l_V, l_O sector is given by $\sigma_V^{l_V,l_O}$ from equation (28). This share is higher in sectors with more productivity dispersion: $\frac{\partial \sigma_V^{l_V,l_O}}{\partial z} < 0$. A weaker sectoral cost advantage of unethical production (higher ν^u) or a stronger deniability mechanism (through an increase of γ_O^u) affect the share as follows:*[15]

- *In e,e sectors, neither ν^u nor γ_O^u affect $\sigma_V^{e,e}$: $\frac{\partial \sigma_V^{e,e}}{\partial \nu^u} = 0$ and $\frac{\partial \sigma_V^{e,e}}{\partial \gamma_O^u} = 0$.*
- *In e,u sectors, a weaker cost advantage of unethical production increases the share of integrating firms and rising deniability increases the share of outsourcing firms: $\frac{\partial \sigma_V^{e,u}}{\partial \nu^u} > 0$ and $\frac{\partial \sigma_V^{e,u}}{\partial \gamma_O^u} < 0$.*
- *In u,u sectors, the cost advantage of unethical production does not affect the prevalence of organizational forms but rising deniability increases the share of outsourcing firms: $\frac{\partial \sigma_V^{u,u}}{\partial \nu^u} = 0$ and $\frac{\partial \sigma_V^{u,u}}{\partial \gamma_O^u} < 0$.*

Proof. See appendix A.4.

Interpreting the lower no-boycott probability under integration as compared to outsourcing ($\gamma_V^u < \gamma_O^u$) as an outcome of the firm's lower credibility when denying responsibility

[14] Note that proposition 4 applies only to the benchmark scenario, whereas the share integrating firms is 1 in the only integration scenario and 0 in the only outsourcing scenario.

[15] These predictions only apply to small changes in ν^u and γ_O^u: changes in γ_O^u must be small enough to stay within the benchmark scenario; changes in ν^u must not alter the sector type.

for the technology employed by an integrated supplier, a stronger deniability mechanism is reflected by an increase of the ratio $\frac{\gamma_O^u}{\gamma_V^u}$. Specifically, in proposition 4, this is modeled as an increase of γ_O^u, the no-boycott probability under outsourcing.[16] For the prevalence of organizational forms in e,e sectors, deniability plays no role:[17] as all firms produce ethically, only the Antràs mechanism determines the choice of organizational form. In e,u sectors, an increase of γ_O^u strengthens the unethical mechanism, which increases adjustable profits under outsourcing. In figure 5, this increases the slope of $\mathrm{E}\left(\pi_O^{l_O=u}\right)$ (green dotted line), which decreases the share of active firms that integrate in two ways: Firstly, the reduction of the adjustable profits advantage offered by integration moves $\tilde{\theta}^{e,u}$ (the intersection with $\mathrm{E}\left(\pi_V^{l_V=e}\right)$) to the right; i.e., the minimum productivity such that the increase of fixed costs due to integration can be offset increases and therefore fewer firms integrate. Secondly, the entry cutoff ($\hat{\theta}_O^{l_O=u}$) decreases such that fewer firms exit but outsource instead. This increase of the number of active firms further reduces the share of active firms that integrate. In u,u sectors, the stronger deniability mechanism also fosters outsourcing. Graphically, this results in an increase of the slope of $\mathrm{E}\left(\pi_O^{l_O=u}\right)$ as in e,u sectors.

Like γ_O^u, the cost advantage of unethical production ν^u cannot have any impact on the share of integrating firms in e,e sectors because all firms produce ethically. In e,u sectors, an increase of ν^u (a weaker cost advantage) reduces the unethical mechanism's push for outsourcing. Graphically, the profit line under outsourcing in figure 5 becomes flatter when outsourcing coincides with lower cost savings. This reduces the number of active firms ($\hat{\theta}_O^{l_O=u}$ increases) and for those who do not exit, the minimum productivity to integrate ($\tilde{\theta}^{e,u}$) declines, leading to a higher share of integrating firms ($\frac{\partial \sigma_V^{e,u}}{\partial \nu^u} > 0$). In u,u sectors, a weaker cost advantage (higher ν^u) diminishes the slope of the profit line under integration as well as the slope of the profit line under outsourcing in figure 5. However, as an increase of ν^u reduces their slopes by the same factor, their intersection ($\tilde{\theta}^{u,u}$) moves unambiguously to the right, which ceteris paribus increases the share of outsourcing firms and decreases the prevalence of integration. Yet, $\mathrm{E}\left(\pi_O^{l_O=u}\right)$ becoming flatter also increases the entry cutoff ($\hat{\theta}_O^{l_O=u}$), driving outsourcing firms out of the market. These two effects exactly offset each other, such that a change in the cost advantage of unethical production has no effect on the prevalence of organizational forms in u,u sectors ($\frac{\partial \sigma_V^{u,u}}{\partial \nu^u} = 0$).

Figure 6 illustrates the relationship between the cost advantage of unethical production (ν^u) and the share of active firms who integrate in a given sector ($\sigma_V^{l_V,l_O}$) as well as the

[16] Rising deniability could also be modeled by a decrease of γ_V^u (an increase of the boycott risk under integration). This, however, would make the comparative statics in proposition 4 less interesting because γ_V^u is irrelevant for e,u sectors.

[17] Note that this (and the following argument on the effect of ν^u) refers to individual sectors of type l_V, l_O, not to the aggregate of all sectors of a given type. A change of γ_O^u moves the technology cutoff $\tilde{\nu}_O$, which constitutes the boundary between e,u and e,e sectors. This, however, does not affect the comparative statics from proposition 4, as these consider individual sectors and changes that are sufficiently small such that the sector under consideration does not change its type (see footnote 15).

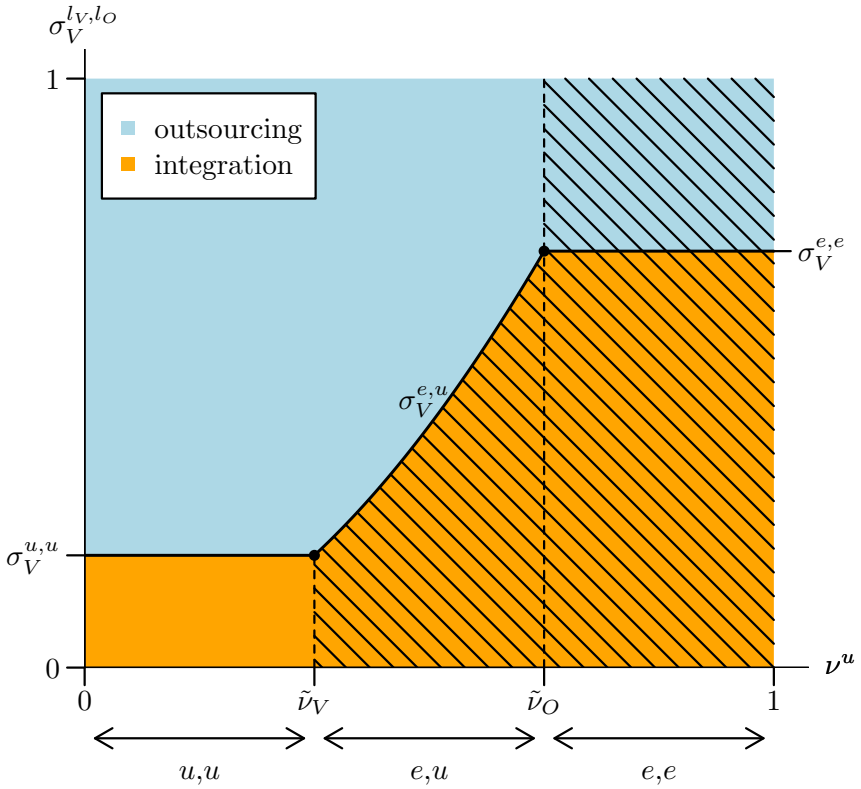

Figure 6: Prevalence of organizational forms by sector type. The share of active firms who integrate in an l_V, l_O sector is given by $\sigma_V^{l_V,l_O}$. The plot depicts segments of $\sigma_V^{u,u}$ (for u,u sectors), $\sigma_V^{e,u}$ (for e,u sectors) and $\sigma_V^{e,e}$ (for e,e sectors). The shading lines indicate the share of firms with ethical suppliers in a given sector.

prevalence of unethical production.[18] The two kinks in the plot of the share of integrating firms highlight how $\frac{\partial \sigma_V^{l_V,l_O}}{\partial \nu^u}$ depends on the sector type (u,u, e,u or e,e) in proposition 4. In e,u sectors, the unethical mechanism makes outsourcing increasingly attractive the stronger the cost advantage of unethical production (lower ν^u). While in e,e sectors, $\sigma_V^{e,e}$ is constant simply because all firms produce ethically, in u,u sectors $\sigma_V^{u,u}$ is constant due to a different reason: The cost advantage of unethical production, ν^u, affects profits under integration as well as under outsourcing. However, any change in the share of integrating firms is exactly offset by entry/exit of low-productivity outsourcing firms.

A second salient feature of figure 6 is that the plot of $\sigma_V^{l_V,l_O}$ is continuous with kinks instead of exhibiting discontinuities at $\tilde{\nu}_V$ and $\tilde{\nu}_O$. This means that the share of integrating

[18] Figure 6 depicts the benchmark scenario (sectors under Case 1 of proposition 3 where equation (21) holds), as only this scenario allows to analyze the interaction of choice of organizational form and choice of technology for sectors with all degrees of unethical cost advantages ($0 < \nu^u < 1$). For the analysis of sectors under Case 2 that allow a coexistence of organizational forms ($\nu^u > \tilde{\nu}^{(2)}$ and equation (21) holds), figure 6 also applies, but only the range where $\nu^u > \tilde{\nu}^{(2)}$ is relevant, as sectors under Case 2 with stronger cost advantages of unethical production are captured by the only outsourcing scenario.

firms in u,u sectors ($\sigma_V^{u,u}$) matches the share in e,u sectors with the strongest possible cost advantage of unethical production ($\sigma_V^{e,u}$, evaluated at $\tilde{\nu}_V$); and the share of integrating firms in e,e sectors ($\sigma_V^{e,e}$) matches the share in e,u sectors with the weakest possible cost advantage of unethical production ($\sigma_V^{e,u}$, evaluated at $\tilde{\nu}_O$). To see that this is true, consider equation (28) and compare $\sigma_V^{e,u}$ to $\sigma_V^{u,u}$ (evaluated at $\tilde{\nu}_V$) and to $\sigma_V^{e,e}$ (evaluated at $\tilde{\nu}_O$): they are equal if $\psi_k^u(\tilde{\nu}_k) = \psi_k^e$, which is true because by equation (18), $\tilde{\nu}_k^{1-\eta}$ and $(\gamma_k^u)^{1/\alpha}$ in $\psi_k^u(\tilde{\nu}_k)$ cancel.

The shading lines in figure 6 indicate the share of active firms that employ ethical technology. In e,u sectors – which are characterized by the feature that firms only integrate their suppliers if they anticipate ethical production – the share of ethical firms matches the share of integrating firms. This relationship breaks in u,u (e,e) sectors, where all suppliers choose the unethical (ethical) technology.

The clear patterns in figure 6 hint at potentially testable implications of the model. The share of integrating firms in a sector should be negatively correlated with the sectoral cost advantage of unethical production. This is in line with findings in Herkenhoff & Krautheim (2022), who show that the share of intrafirm trade depends negatively on the potential cost savings of unethical production in a sector. Moreover, figure 6 suggests that the sectoral share of integrating firms should positively correlate with the share of ethical firms. Investigating this relationship, however, requires to overcome substantial issues of measuring and observing "unethical" production. Any such empirical study should focus on sectors with high headquarter intensities (and high fixed costs of integrating suppliers) in order to satisfy the requirements of the benchmark scenario.

To summarize the findings depicted in figure 6, the share of active firms who integrate is lowest in u,u sectors, highest in e,e sectors and *decreases* in the cost advantage of unethical production in e,u sectors. The same applies to the share of active firms with ethical suppliers.

5. Conclusion

This paper analyzes the prevalence of organizational forms among heterogeneous firms who contract with potentially unethical suppliers, which exposes the firms to the risk of being target of a consumer boycott. To this end, the paper introduces a cost-saving technology – considered *unethical* by consumers and modeled following Herkenhoff & Krautheim (2022) – into the framework of the international organization of production by Antràs & Helpman (2004).

The model reveals that the choice of organizational form is shaped by three mechanisms that (dis-) incentivize integration of the supplier: Firstly, the well-known *Antràs mechanism* incentivizes integration in sectors with sufficiently high headquarter intensities. Secondly, the *unethical mechanism* (which is only active in sectors where the supplier chooses

the ethical technology under integration but produces unethically under outsourcing) captures the trade-off between the cost savings from employing the unethical technology and the boycott risk. In all cases where this mechanism is relevant, the advantages from the cost savings dominate and hence the unethical mechanism fosters outsourcing. Thirdly, the *deniability mechanism* (which is only active in sectors where the supplier produces unethically regardless of the organizational form) incentivizes outsourcing, because outsourcing an unethical supplier gives the firm more credibility when denying responsibility for the supplier's choice of technology, which is reflected in a lower boycott risk under outsourcing.

Considering an equilibrium with free entry of firms, the paper analyzes the determinants of the share of active firms choosing each organizational form. In particular, the share of integrating firms is higher in sectors with stronger productivity dispersion and it weakly decreases in the strength of the cost advantage of unethical production. If the deniability mechanism becomes stronger, the share of integrating firms declines.

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Appendix A. Proofs

A.1. Proof of Proposition 1 – Choice of Technology

Unethical technology is chosen if $\mathrm{E}\left(\pi(i)^{e}_{Mk}\right) < \mathrm{E}\left(\pi(i)^{u}_{Mk}\right)$ (see equation (16)). Adding $t + w^{N} f_{Mk}$ to both sides of the inequality and canceling yields $\psi^{e}_{k} < \psi^{u}_{k}$. Plug in equation (13) to obtain:

$$\frac{(\gamma^{e}_{k})^{\frac{1}{\alpha}}}{(\nu^{e})^{1-\eta}} < \frac{(\gamma^{u}_{k})^{\frac{1}{\alpha}}}{(\nu^{u})^{1-\eta}}.$$

No boycotts ($\gamma^{e}_{k} = 1$) and no cost advantage ($\nu^{e} = 1$) under ethical production implies:

$$\begin{aligned} \nu^{u} &< \tilde{\nu}_{k}, \\ \text{where} \qquad \tilde{\nu}_{k} &\equiv (\gamma^{u}_{k})^{\frac{1}{\alpha(1-\eta)}}. \end{aligned} \tag{18}$$

Note that $\frac{\partial \tilde{\nu}_{k}}{\partial \gamma^{u}_{k}} = \frac{1}{\alpha(1-\eta)} \, (\gamma^{u}_{k})^{\frac{1}{\alpha(1-\eta)}-1} > 0$. As $\gamma^{u}_{V} < \gamma^{u}_{O}$, this implies $\tilde{\nu}_{V} < \tilde{\nu}_{O}$. Therefore:

- If $\nu^{u} < \tilde{\nu}_{V}$ (u,u sectors): The condition is sufficient for $\nu^{u} < \tilde{\nu}_{O}$, which is why the supplier is unethical regardless of k in u,u sectors.
- If $\tilde{\nu}_{V} \leq \nu^{u} < \tilde{\nu}_{O}$ (e,u sectors): Here, the supplier's decision depends on k. Under integration, the relevant cutoff is $\tilde{\nu}_{V}$ and the supplier is ethical (because $\tilde{\nu}_{V} \leq \nu^{u}$). Under outsourcing, the relevant cutoff is $\tilde{\nu}_{O}$ and the supplier is unethical (because $\nu^{u} < \tilde{\nu}_{O}$).
- If $\tilde{\nu}_{O} \leq \nu^{u}$ (e,e sectors): The condition is sufficient for $\tilde{\nu}_{V} \leq \nu^{u}$, which is why the supplier is ethical regardless of k in e,e sectors. □

A.2. Proof of Proposition 2 – Choice of Organizational Form

The firm prefers integration if $\mathrm{E}(\pi(i)^{l_V}_{V}) > \mathrm{E}(\pi(i)^{l_O}_{O})$, taking into account the technology choice under integration (l_V) and outsourcing (l_O) implied by proposition 1. Using equation (17), this implies

$$(X^{\mu-\alpha} \, \theta^{\alpha})^{\frac{1}{1-\alpha}} \, (\psi^{l_V}_{V} - \psi^{l_O}_{O}) > w^{N} \, (f_V - f_O). \tag{A.1}$$

Option 1: If $\psi^{l_V}_{V} > \psi^{l_O}_{O}$, solving for θ yields

$$\begin{aligned} \theta &> \tilde{\theta}^{l_V, l_O}, \\ \text{where} \qquad \tilde{\theta}^{l_V, l_O} &\equiv X^{\frac{\alpha-\mu}{\alpha}} \left[w^{N} \, \frac{f_V - f_O}{\psi^{l_V}_{V} - \psi^{l_O}_{O}} \right]^{\frac{1-\alpha}{\alpha}}. \end{aligned} \tag{19}$$

In option 1, the firm prefers integration if $\theta > \tilde{\theta}^{l_V, l_O}$ and outsourcing otherwise.

Option 2: If $\psi_V^{l_V} < \psi_O^{l_O}$, the inequality (A.1) can never hold because the expression on the left-hand side is negative and therefore never larger than the positive term on the right-hand side. Therefore, the firm prefers outsourcing if $\psi_V^{l_V} < \psi_O^{l_O}$.

Combining option 1 and option 2, the firm prefers integration if $\psi_V^{l_V} > \psi_O^{l_O}$ and $\theta > \tilde{\theta}^{l_V,l_O}$; it prefers outsourcing in all other cases.[19] □

A.3. Proof of Proposition 3 – Possibility of Integration

No firm will prefer integration unless $\psi_V^{l_V} > \psi_O^{l_O}$ (see proposition 2). Using equation (13) and canceling, this implies that integration is only possible if

$$\left(\frac{\gamma_O^{l_O}}{\gamma_V^{l_V}}\right)^{\frac{1}{\alpha}} \left(\frac{\nu^{l_V}}{\nu^{l_O}}\right)^{1-\eta} < \bar{\phi}, \tag{A.2}$$

where $\bar{\phi} \equiv \frac{\phi_V}{\phi_O}$.

For the three sector types with $\{l_V = u; l_O = u\}, \{l_V = e; l_O = u\}$ and $\{l_V = e; l_O = e\}$, equation (A.2) implies the following corresponding conditions (noting that $\gamma_k^e = \nu^e = 1$):

$$\left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{\frac{1}{\alpha}} < \bar{\phi}, \tag{A.2^{u,u}}$$

$$(\gamma_O^u)^{\frac{1}{\alpha}} \left(\frac{1}{\nu^u}\right)^{1-\eta} < \bar{\phi}, \tag{A.2^{e,u}}$$

$$1 < \bar{\phi}. \tag{A.2^{e,e}}$$

Only when these conditions hold, integration is possible in sectors of the respective type.

Consider equation (A.2^{e,u}). Importantly, the left-hand side is continuous and decreasing in ν^u, so the inequality tends to hold the weaker the cost advantage of unethical production (high ν^u) in a sector. Recall from proposition 1 that e,u sectors are sectors with $\tilde{\nu}_V \leq \nu^u < \tilde{\nu}_O$. For the e,u sectors with the strongest cost advantage ($\nu^u = \tilde{\nu}_V$), equation (A.2^{e,u}) becomes equation (A.2^{u,u}); for the e,u sectors with the weakest cost advantage of unethical production ($\nu^u \to \tilde{\nu}_O$), equation (A.2^{e,u}) approaches equation (A.2^{e,e}). Both follows from substituting equation (18). This has two implications: Firstly, if equation (A.2^{u,u}) holds, equation (A.2^{e,u}) holds for $\nu^u \to \tilde{\nu}_V$ and therefore also for *all* other e,u sectors as these exhibit larger values of ν^u, only making the left-hand side of equation (A.2^{e,u}) even smaller. Secondly, if equation (A.2^{e,e}) does *not* hold, equation (A.2^{e,u}) holds for no e,u sector, because if equation (A.2^{e,u}) does not hold for $\nu^u = \tilde{\nu}_O$, it cannot hold for any $\nu^u < \tilde{\nu}_O$.

As $1 < \left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{1/\alpha}$ (because $\gamma_V^u < \gamma_O^u$), equation (A.2^{u,u}) is sufficient for equation (A.2^{e,e}). Together with the above analysis of equation (A.2^{e,u}), this allows for only three cases:

[19] This assumes that in the edge case where the firm is indifferent because $\psi_O^{l_V} = \psi_O^{l_O}$, outsourcing is chosen.

Case 1: $1 < \left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{\frac{1}{\alpha}} < \bar{\phi}$. Equations (A.2^{u,u}) and (A.2^{e,e}) clearly hold. The former ensures that equation (A.2^{e,u}) holds as well (for all e,u sectors). Therefore, integration is possible in all u,u, e,u and e,e sectors.

Case 2: $1 < \bar{\phi} \leq \left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{\frac{1}{\alpha}}$. Equation (A.2^{u,u}) is violated; equation (A.2^{e,e}) holds. This rules out integration in u,u sectors but allows it in e,e sectors. For e,u sectors, equation (A.2^{e,u}) may or may not hold, depending on the respective sectors' ν^u. Solving for ν^u yields the condition $\nu^u > \bar{\phi}^{\frac{1}{\eta-1}}\,\tilde{\nu}_O$.

Case 3: $\bar{\phi} \leq 1 < \left(\frac{\gamma_O^u}{\gamma_V^u}\right)^{\frac{1}{\alpha}}$. Equations (A.2^{u,u}) and (A.2^{e,e}) are clearly violated. This also rules out that equation (A.2^{e,u}) holds for any e,u sector. □

A.4. Proof of Proposition 4 – Prevalence of Organizational Forms

Equation (28) follows directly from plugging equations (4), (19) and (20) into the definition of the share of active firms that choose integration in a l_V, l_O sector as given by equation (27).

Sectors with higher values of z have less productivity dispersion. As the base in equation (28) must be a share between 0 and 1, increasing the exponent decreases $\sigma_V^{l_V,l_O}$: $\frac{\partial \sigma_V^{l_V,l_O}}{\partial z} < 0$. Therefore, higher productivity dispersion increases the share of integrating firms.

Before turning to the partial derivatives of $\sigma_k^{l_V,l_O}$, consider ψ_k^l from equation (13) to note that $\frac{\partial \psi_O^u}{\partial \nu^u} < 0$ and $\frac{\partial \psi_O^u}{\partial \gamma_O^u} > 0$. Besides, $\frac{\partial \psi_k^e}{\partial \nu^u} = \frac{\partial \psi_k^e}{\partial \gamma_O^u} = 0$, because adjustable profits with ethical technology are unaffected by the cost advantage of unethical production and the no-boycott risk.

e,e sectors By inspection of equation (28), $\frac{\partial \sigma_V^{e,e}}{\partial \nu^u} = 0$ and $\frac{\partial \sigma_V^{e,e}}{\partial \gamma_O^u} = 0$ follow from $\frac{\partial \psi_k^e}{\partial \nu^u} = \frac{\partial \psi_k^e}{\partial \gamma_O^u} = 0$.

e,u sectors By inspection of equation (28), $\frac{\partial \sigma_V^{e,u}}{\partial \nu^u} > 0$ follows from $\frac{\partial \psi_V^e}{\partial \nu^u} = 0$ and $\frac{\partial \psi_O^u}{\partial \nu^u} < 0$: the denominator of $\frac{\psi_V^e - \psi_O^u}{\psi_O^u}$ decreases and the numerator increases. $\frac{\partial \sigma_V^{e,u}}{\partial \gamma_O^u} < 0$ follows from $\frac{\partial \psi_O^u}{\partial \gamma_O^u} > 0$: the denominator of $\frac{\psi_V^e - \psi_O^u}{\psi_O^u}$ increases and the numerator decreases.

u,u sectors For $\frac{\partial \sigma_V^{u,u}}{\partial \nu^u} = 0$, consider the fraction $\frac{\psi_V^u - \psi_O^u}{\psi_O^u}$ in equation (28): ν^u (raised to the power $-\frac{(1-\eta)\alpha}{1-\alpha}$) can be factored out from the difference in the numerator as well as from ψ_O^u and hence cancels. $\frac{\partial \sigma_V^{u,u}}{\partial \gamma_O^u} < 0$ follows from $\frac{\partial \psi_O^u}{\partial \gamma_O^u} > 0$: the denominator of $\frac{\psi_V^u - \psi_O^u}{\psi_O^u}$ increases and the numerator decreases (γ_O^u has no effect on ψ_V^u). □

Appendix B. Derivations

B.1. Equilibrium Investments

Let $\tilde{\pi}(i)^l_{Hk} = \beta_k \ \mathrm{E}[R(i)^l_k] - w^N \ h(i)^l_k$ and $\tilde{\pi}(i)^l_{Mk} = (1-\beta_k) \ \mathrm{E}[R(i)^l_k] - \nu^l \, w^S \ m(i)^l_k$. This allows to rewrite equations (9) and (10) concisely as

$$h(i)^l_k = \underset{h(i)^l_k}{\arg\max} \ \tilde{\pi}(i)^l_{Hk}$$
$$\text{and} \qquad m(i)^l_k = \underset{m(i)^l_k}{\arg\max} \ \tilde{\pi}(i)^l_{Mk}.$$

The first order conditions $\frac{\partial \tilde{\pi}(i)^l_{Hk}}{\partial h(i)^l_k} \stackrel{!}{=} 0$ and $\frac{\partial \tilde{\pi}(i)^l_{Mk}}{\partial m(i)^l_k} \stackrel{!}{=} 0$ yield

$$\alpha\eta \ \beta_k \ \gamma^l_k \ X^{\mu-\alpha} \ \theta^\alpha \ \eta^{-\alpha\eta}(1-\eta)^{-\alpha(1-\eta)} \, (h(i)^l_k)^{\alpha\eta-1} \ (m(i)^l_k)^{\alpha(1-\eta)} = w^N$$

for the headquarter and

$$\alpha(1-\eta) \, (1-\beta_k) \ \gamma^l_k \ X^{\mu-\alpha} \ \theta^\alpha \ \eta^{-\alpha\eta}(1-\eta)^{-\alpha(1-\eta)} \, (h(i)^l_k)^{\alpha\eta} \ (m(i)^l_k)^{\alpha(1-\eta)-1} = \nu^l \, w^S$$

for the supplier. These equations can be solved for $h(i)^l_k$ and $m(i)^l_k$, respectively, to obtain the best response functions of both agents:

$$h(i)^l_k = \left[\frac{w^N}{\alpha\eta \ \beta_k \ \gamma^l_k \ X^{\mu-\alpha} \ \theta^\alpha \ \eta^{-\alpha\eta}(1-\eta)^{-\alpha(1-\eta)}} \left(m(i)^l_k \right)^{-\alpha(1-\eta)} \right]^{\frac{1}{\alpha\eta-1}}, \tag{B.1}$$

$$m(i)^l_k = \left[\frac{\nu^l \, w^S}{\alpha(1-\eta) \, (1-\beta_k) \ \gamma^l_k \ X^{\mu-\alpha} \ \theta^\alpha \ \eta^{-\alpha\eta}(1-\eta)^{-\alpha(1-\eta)}} \left(h(i)^l_k \right)^{-\alpha\eta} \right]^{\frac{1}{\alpha(1-\eta)-1}}. \tag{B.2}$$

Combining the best response functions from equations (B.1) and (B.2) delivers the equilibrium investments as given by equations (11) and (12).

B.2. Consumption Index

To derive the consumption index for the benchmark scenario, start from equation (24). Plug in equations (4) and (17) (using $g(\theta) \equiv \frac{\mathrm{d}G(\theta)}{\mathrm{d}\theta}$) to obtain:

$$\frac{w^N \, f_E}{z b^z} = \int_{\hat{\theta}^{l_O}_O}^{\tilde{\theta}^{l_V, l_O}} X^{\frac{\mu-\alpha}{1-\alpha}} \ \psi^{l_O}_O \ \theta^{\frac{\alpha}{1-\alpha}-z-1} - w^N \, f_O \ \theta^{-z-1} \, \mathrm{d}\theta +$$
$$\int_{\tilde{\theta}^{l_V, l_O}}^{\infty} X^{\frac{\mu-\alpha}{1-\alpha}} \ \psi^{l_V}_V \ \theta^{\frac{\alpha}{1-\alpha}-z-1} - w^N \, f_V \ \theta^{-z-1} \, \mathrm{d}\theta$$

$$\Leftrightarrow \quad \frac{w^N f_E}{z b^z} = \Big[-\mathcal{C}_1 \; X^{\frac{\mu-\alpha}{1-\alpha}} \; \psi_O^{l_O} \; \theta^{\frac{\alpha}{1-\alpha}-z} + \frac{w^N f_O}{z} \; \theta^{-z}\Big]_{\hat{\theta}_O^{l_O}}^{\tilde{\theta}^{l_V,l_O}} + \Big[-\mathcal{C}_1 \; X^{\frac{\mu-\alpha}{1-\alpha}} \; \psi_V^{l_V} \; \theta^{\frac{\alpha}{1-\alpha}-z} + \frac{w^N f_V}{z} \; \theta^{-z}\Big]_{\tilde{\theta}^{l_V,l_O}}^{\infty},$$

where $\mathcal{C}_1 \equiv -\frac{1}{\frac{\alpha}{1-\alpha}-z}$. Assuming $\frac{\alpha}{1-\alpha} < z$, evaluating the integrals yields:

$$\frac{w^N f_E}{z b^z} = \mathcal{C}_1 \; X^{\frac{\mu-\alpha}{1-\alpha}} \; (\psi_V^{l_V} - \psi_O^{l_O}) \; (\tilde{\theta}^{l_V,l_O})^{\frac{\alpha-z(1-\alpha)}{1-\alpha}} - \frac{w^N (f_V - f_O)}{z} \; (\tilde{\theta}^{l_V,l_O})^{-z} + \mathcal{C}_1 \; X^{\frac{\mu-\alpha}{1-\alpha}} \; \psi_O^{l_O} \; (\hat{\theta}_O^{l_O})^{\frac{\alpha-z(1-\alpha)}{1-\alpha}} - \frac{w^N f_O}{z} \; (\hat{\theta}_O^{l_O})^{-z}.$$

Plug in equations (19) and (20) and manipulate to obtain

$$\frac{w^N f_E}{z b^z} = \mathcal{C}_1 \; (\psi_V^{l_V} - \psi_O^{l_O}) \left(w^N \frac{f_V - f_O}{\psi_V^{l_V} - \psi_O^{l_O}}\right)^{\frac{\alpha-z(1-\alpha)}{\alpha}} X^{-z\frac{\alpha-\mu}{\alpha}} - \frac{w^N (f_V - f_O)}{z} \left(w^N \frac{f_V - f_O}{\psi_V^{l_V} - \psi_O^{l_O}}\right)^{\frac{-z(1-\alpha)}{\alpha}} X^{-z\frac{\alpha-\mu}{\alpha}} + \mathcal{C}_1 \; \psi_O^{l_O} \left(\frac{w^N f_O}{\psi_O^{l_O}}\right)^{\frac{\alpha-z(1-\alpha)}{\alpha}} X^{-z\frac{\alpha-\mu}{\alpha}} - \frac{w^N f_O}{z} \left(\frac{w^N f_O}{\psi_O^{l_O}}\right)^{\frac{-z(1-\alpha)}{\alpha}} X^{-z\frac{\alpha-\mu}{\alpha}},$$

which allows to move X to the left-hand side. Using $\mathcal{C}_X = \frac{1}{z-\frac{\alpha}{1-\alpha}} - \frac{1}{z}$, the remaining terms on the right-hand side can then be written as

$$\frac{w^N f_E}{z b^z} X^{z\frac{\alpha-\mu}{\alpha}} = \mathcal{C}_X \; (\psi_V^{l_V} - \psi_O^{l_O}) \left(w^N \frac{f_V - f_O}{\psi_V^{l_V} - \psi_O^{l_O}}\right)^{\frac{\alpha-z(1-\alpha)}{\alpha}} + \mathcal{C}_X \; \psi_O^{l_O} \left(\frac{w^N f_O}{\psi_O^{l_O}}\right)^{\frac{\alpha-z(1-\alpha)}{\alpha}}$$

$$\Leftrightarrow \quad X^{l_V,l_O} \equiv X = \left[\frac{\mathcal{C}_X \, z b^z}{w^N f_E} \left[(\psi_V^{l_V} - \psi_O^{l_O})\left(w^N \frac{f_V - f_O}{\psi_V^{l_V} - \psi_O^{l_O}}\right)^{\frac{\alpha-z(1-\alpha)}{\alpha}} + \psi_O^{l_O}\left(\frac{w^N f_O}{\psi_O^{l_O}}\right)^{\frac{\alpha-z(1-\alpha)}{\alpha}}\right]\right]^{\frac{\alpha}{z(\alpha-\mu)}}. \tag{25}$$

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